NASA SP-7037 (04)

AERONAUTICAL ENGINEERING

A SPECIAL BIBLIOGRAPHY WITH INDEXES

Supplement 4

APRIL 1971

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

PREVIOUS BIBLIOGRAPHIES IN THIS SERIES

Document	*Date*	*Coverage*
NASA SP-7037	September 1970	Jan.–Aug. 1970
NASA SP-7037 (01)	January 1971	Sept.–Dec. 1970
NASA SP-7037 (02)	February 1971	January 1971
NASA SP-7037 (03)	March 1971	February 1971

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AERONAUTICAL ENGINEERING

A Special Bibliography

Supplement 4

A selection of annotated references to unclassified reports and journal articles that were introduced into the NASA scientific and technical information system and announced in March 1971 in

- *Scientific and Technical Aerospace Reports (STAR)*
- *International Aerospace Abstracts (IAA).*

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INTRODUCTION

Under the terms of an interagency agreement with the Federal Aviation Administration this publication has been prepared by the National Aeronautics and Space Administration for the joint use of both agencies and the scientific and technical community concerned with the field of aeronautical engineering.

This supplement to *Aeronautical Engineering—A Special Bibliography* (NASA SP-7037) lists 376 reports, journal articles, and other documents originally announced in March 1971 in *Scientific and Technical Aerospace Reports (STAR)* or in *International Aerospace Abstracts (IAA)*. For previous bibliographies in this series, see inside of front cover.

The coverage includes documents on the engineering and theoretical aspects of design, construction, evaluation, testing, operation, and performance of aircraft (including aircraft engines) and associated components, equipment, and systems. It also includes research and development in aerodynamics, aeronautics, and ground support equipment for aeronautical vehicles.

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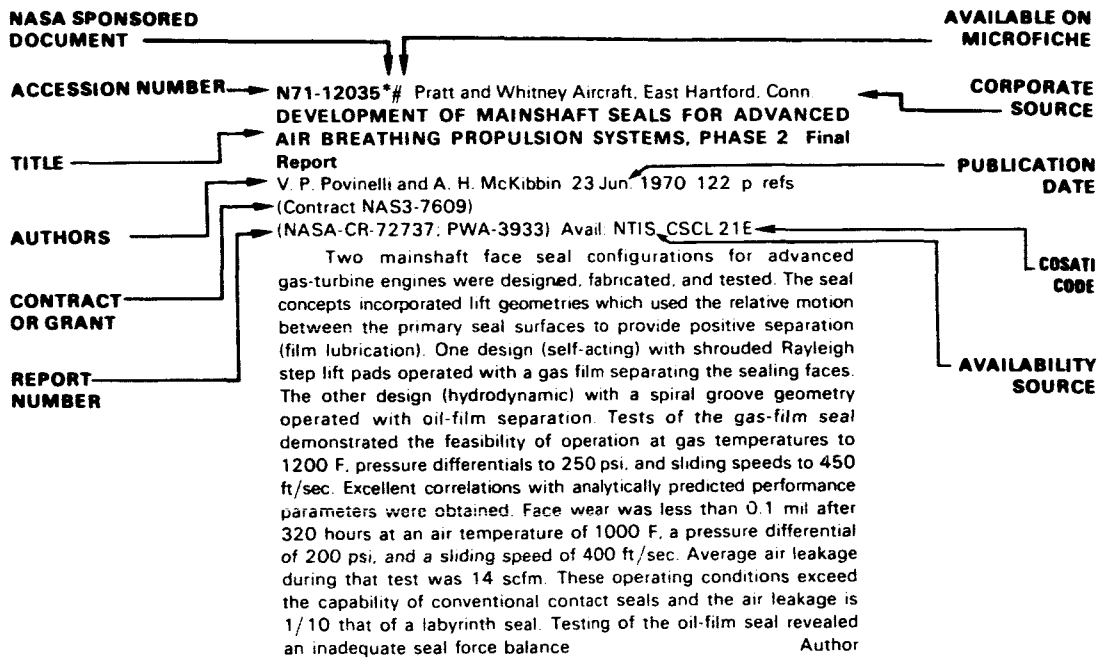

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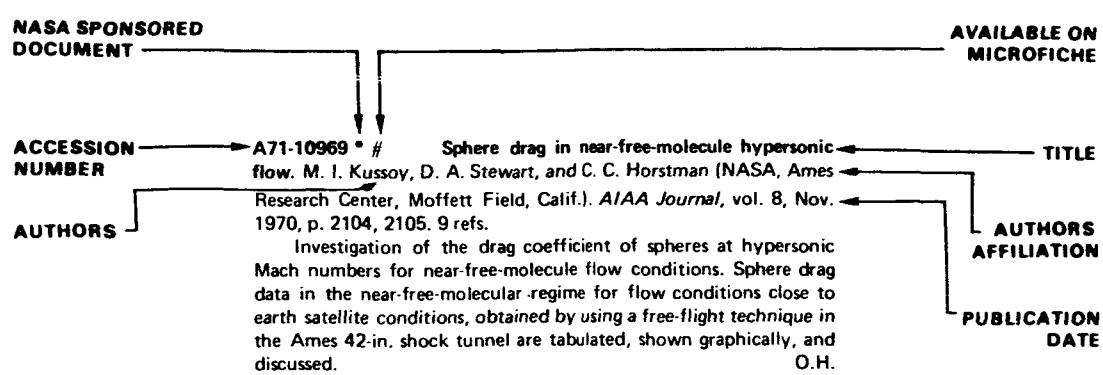

AERONAUTICAL ENGINEERING

A Special Bibliography (Suppl. 4) APRIL 1971

IAA ENTRIES

A71-15947 # **Calculation of the aerodynamics of a wing impinged by several slipstreams (Berechnung der Aerodynamik des von mehreren Strahlen beaufschlagten Tragflügels).** G. Löbert (Vereinigte Flugtechnische Werke-Fokker GmbH, Munich, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt, Jahrestagung, 3rd, Düsseldorf, West Germany, Dec. 3, 4, 1970, Paper DGLR 70-057.* 43 p. 8 refs. In German.

After a brief description of the theory of Levinsky, Thommen, Yager and Holland, the suitability of this method of calculating the aerodynamics of a wing immersed in one or more slipstreams is investigated by a comparison with experimental results. The comparison is conducted on the basis of lift, drag, pitching moment, normal-force distribution and wake characteristics. The paper closes with an investigation of the influence of the main propeller-wing-characteristics on the descent capability of propeller-driven V/STOL aircraft. (Author)

A71-15948 **Flight-mechanical takeoff and landing investigations of a VTOL aircraft using different control systems in hovering flight (Flugmechanische Start- und Landeuntersuchungen eines VTOL-Flugzeuges bei Verwendung verschiedener Steuersysteme im Schwebeflug).** H. Kolar and G. Schneider (Messerschmitt-Bölkow-Blohm GmbH, Munich, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt, Jahrestagung, 3rd, Düsseldorf, West Germany, Dec. 3, 4, 1970, Paper DGLR 70-073.* 48 p. In German.

Study of the qualifications of two systems involving the control of attitude and of velocity, respectively, for takeoff and landing operations of a VTOL aircraft. The devices used for the simulation are considered, and the operations which were performed by pilots in order to test the control systems are described. The evaluation discussed is based on objective data regarding deviations from the ideal flight path, the work of the pilot, and the frequency of the fuel-control-units, and on subjective impressions of the pilots. G.R.

A71-15951 # **Effect of a jet on the aerodynamic parameters of wings positioned above the jet (Einfluss eines Düsenstrahls auf die aerodynamischen Beiwerte von über der Strahldüse angeordneten Flügeln).** W. Baumert and L. Harms (Aerodynamische Versuchsanstalt, Göttingen, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt, Jahrestagung, 3rd, Düsseldorf, West Germany, Dec. 3, 4, 1970, Paper DGLR 70-052.* 22 p. In German.

Experimental investigation of the influence of a jet on two types of wings (rectangular and swept) positioned above the jet, the location, inclination, and velocity of which was varied. The wing and the nozzle were mounted separately so that the wind tunnel balance did not measure the thrust of the jet; a simple determination of the jet interference was thus possible. It is found that the jet decreases the lift of the wing considerably. For the investigated ratio of jet velocity and free stream velocity of 2 to 17, the lift loss increases approximately linearly with this ratio. The lift loss also varies with the jet angle. The pitching moment also depends on the velocity ratio and varies markedly with the position of the jet. O.H.

A71-15953 # **Interference effects from jets on aircraft static stability - Wind tunnel methods used in Sweden.** Gustaf Bennich (SAAB-SCANIA, Linköping, Sweden). *Deutsche Gesellschaft für Luft- und Raumfahrt, Jahrestagung, 3rd, Düsseldorf, West Germany, Dec. 3, 4, 1970, Paper DGLR 70-048.* 15 p.

Discussion of equipment and approaches used in investigations of interference effects from jets on the stability of aircraft with ejector afterbody. Approaches used in the drag measurement are considered, and jet effects on yaw stability for twin engined aircraft are examined. The development of a special model support for studies of aircraft with ejector afterbody is described. A six-component balance is used for stability measurements which is a development of the annular balance used in the drag measurements. A general assembly drawing of the installation used in the investigations is shown. G.R.

A71-15954 # **Some experiments on an engine installation above the wing of a swept-winged aircraft.** J. A. Bagley (Royal Aircraft Establishment, Farnborough, Hants., England). *Deutsche Gesellschaft für Luft- und Raumfahrt, Jahrestagung, 3rd, Düsseldorf, West Germany, Dec. 3, 4, 1970, Paper.* 12 p.

Preliminary study of the aerodynamic features of a design involving an engine installation above the wing of a swept-winged aircraft. Tests were conducted on a partial model of the wing and nacelle. Details of the interference between a jet from an external supply and the wing were investigated by measuring pressures on the wing, by surveys of the total-head distribution in the jet, and by schlieren and oil-flow photography. Measurements in a low-speed wind tunnel of the forces on a model of a swept wing and fuselage, fitted with a pair of free-flow nacelles are discussed. The results suggest that the lift-dependent drag of such an installation may be significantly larger than that of a conventional installation below the wing. G.R.

A71-15956 # **The effect of impressions of motion on guidance errors at simulated ILS approaches (Der Einfluss von Bewegungseindrücken auf Führungsfehler bei simulierten ILS-Anflügen).** Friedrich Erdmann and Rudolf Dierke (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Institut für Flugführung, Braunschweig, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt, Jahrestagung, 3rd, Düsseldorf, West Germany, Dec. 3, 4, 1970, Paper DGLR 70-071.* 14 p. In German.

Discussion of a theory for representing impressions of motion with moving-cockpit simulators taking into consideration an application of the theory and some experimental results. The digital flight simulator used in the investigations is considered. The influence of a simple model derived on the basis of a theory proposed by Erdman (1970) on the operations to be performed by a pilot during ILS approaches is investigated. Experimental results obtained during ILS approaches with and without impressions of motion are discussed. G.R.

A71-15961 # **Turbulent and laminar jet propagation in rotating systems and its application regarding the mixing of the jet in the downwash field of rotors employing jet propulsion (Turbulente und laminare Strahlausbreitung in rotierenden Systemen und ihre Anwendung auf die Strahlmischung im Abwindfeld von Rotoren mit Reaktionsantrieben).** R. Schmidt and J. T. Heynatz (Dornier System GmbH, Friedrichshafen, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt, Jahrestagung, 3rd, Düsseldorf, West Germany, Dec. 3, 4, 1970, Paper DGLR 70-050.* 39 p. 23 refs. In German.

Study of jet propagation in rotating systems on the basis of the kinematic and dynamic principles involved giving attention to aspects of jet deflection in the downwash field of a rotor. Basic physical relations regarding the propagation of a jet which emerges from a rotating blade in a tangential direction are derived using a stationary coordinate system. Three characteristic cases with regard to the position of the jet and the direction of the velocity are discussed. The cases of the planar, the round laminar, and the turbulent jet are examined on the basis of typical relations regarding the mixing of a jet. Questions of transformations regarding the obtained relations in case of a change to another coordinate system are investigated. Some pictures obtained in experimental investigations showing the characteristics of jet propagation are presented. G.R.

A71-15965 # **Evaluation of free-flight simulations with a helicopter of variable stability and maneuverability with regard to its suitability as an aid in aircraft development (Auswertung von Freiflug-Simulationen mit einem Hubschrauber variabler Stabilität und Steuerbarkeit im Hinblick auf seine Eignung als Hilfsmittel bei der Flugzeugentwicklung).** H. Schmidtlein (Vereinigte Flugtechnische Werke-Fokker GmbH, Bremen, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt, Jahrestagung, 3rd, Düsseldorf, West Germany, Dec. 3, 4, 1970, Paper DGLR 70-075.* 61 p. 7 refs. In German.

Discussion of the significance of investigations with an airborne simulator as an aid in the development of an aircraft taking into consideration studies conducted by a German aerospace company with a four-degrees-of-freedom V/STOL aircraft airborne simulator of the National Research Council of Canada. A helicopter of the Bell 47-A type had been used for the simulator. The studies involved a simulation of the flight characteristics of the VFW SG-1262 hovering test rig. Factors of the quality of the simulation are examined. It is found that results obtained with the simulator are applicable to the solution of a problem in investigations of the maneuverability. However, the significance of the simulator regarding the simulation of a breakdown in the flight control system is considered doubtful. G.R.

A71-15966 # **Investigations on exhaust-gas jets of jet engine models (Untersuchungen an Abgasstrahlen von TL-Triebwerksmodellen).** Eckart Schwantes (Deutsche Forschungs- und Versuchsanstalt fur Luft- und Raumfahrt, Institut für Luftsaugende Antriebe, Braunschweig, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt, Jahrestagung, 3rd, Düsseldorf, West Germany, Dec. 3, 4, 1970, Paper DGLR 70-055.* 38 p. 21 refs. In German.

Study of free jets at temperatures up to 550 C involving critical nozzle pressure ratio and five convergent nozzles of differing shapes. Great differences in comparison to free jet measurements at low nozzle Mach numbers were found. It is pointed out that the jet is discharged at very high pressure from the convergent nozzle. The jet is accelerated to supersonic velocity, which it retains in its core for approximately five nozzle diameters. Aspects of jet decomposition and spatial jet propagation are less pronounced for high-velocity jets than for free jets with a lower velocity at the nozzle exit. G.R.

A71-15967 # **The effect of an inclined jet on the aerodynamic characteristics of a tail assembly (Der Einfluss eines geneigten Strahls auf die aerodynamischen Eigenschaften eines Leitwerks).** M. Seidel (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Institut für Aerodynamik, Braunschweig, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt, Jahrestagung, 3rd, Düsseldorf, West Germany, Dec. 3, 4, 1970, Paper DGLR 70-053.* 31 p. 19 refs. In German.

Study of the changes regarding the lift at a tail assembly induced by a round cold jet taking into consideration the inclination of the nozzle against the airflow direction. It is pointed out that this inclination is the most important parameter because of its effect on the longitudinal stability of a jet-propelled VTOL aircraft in the transition region. Other parameters investigated include nozzle diameter and its position relative to the tail assembly, and the characteristics of the tail assembly. Aerodynamic processes in case of jet interference are qualitatively examined. It is found that induced losses in lift are in a first approximation the result of a superposition of the effects of the individual parameters. G.R.

A71-15968 # **Applicability of flight simulators without visual and motor impressions of the pilot (Verwendbarkeit von Flugsimulatoren ohne Sicht- und Bewegungseindrücke des Piloten).** Robert Schweinfurth (Vereinigte Flugtechnische Werke-Fokker GmbH, Bremen, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt, Jahrestagung, 3rd, Düsseldorf, West Germany, Dec. 3, 4, 1970, Paper DGLR 70-070.* 41 p. 18 refs. In German.

Study of the possibility of pilot training with the aid of flight simulators without simulation of the visual and motor impressions of the pilot. The possibility of studying the handling qualities of an aircraft in such a flight simulator is discussed, as well as the role of the pilot in the simulation process. The validity of the results obtained from such simulation is assessed, and the requirements imposed on the simulator are indicated. The importance of external stimuli is stressed. Simulation tests of the handling qualities of the SAAB-Viggen, the T-33, and the X-15 aircraft are summarized. The use of the simulator in human-engineering studies is noted. Finally, the experience gained from training simulators without visual and motor simulation is reviewed. A.B.K.

A71-15970 # **Analysis of simulation width and parameter sensitivity of simulators according to the procedure of vector-of-state feedback by means of a root-locus technique for multiparameter control (Analyse der Simulationsbreite und Parameterempfindlichkeit von Simulatoren nach dem Verfahren der Zustandsvektorrückkopplung mittels eines Wurzelortskurvenverfahrens für Mehrgrössenregelung).** Bernd Uhrmeister (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Institut für Dynamik der Flugsysteme, Oberpfaffenhofen, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt, Jahrestagung, 3rd, Düsseldorf, West Germany, Dec. 3, 4, 1970, Paper.* 45 p. In German.

Study of relations between the parameters of the not-controlled aircraft and the characteristics of the simulator regarding simulation width and parameter sensitivity making use of a root-locus technique obtained by modifying a method reported by McRuer et al. (1964). Relations between the aerodynamic parameters of aircraft and model and the simulation width are discussed in detail. Formulas for the simulation width which are valid for every control concept are derived. The relations investigated are employed to determine simulation width for two simulators. The results obtained agree with analog computations. Differences obtained regarding the parameter sensitivity of both simulators are discussed. G.R.

A71-16039 # **Controlling the angle of attack of a space vehicle by varying the position of the center of mass (Upravlenie uglom ataki kosmicheskogo apparata posredstvom izmeneniia tsentrovki).** B. N. Petrov, Zh. S. Ageev, B. V. Viktorov, and I. S. Ukolov. *Kosmicheskie Issledovaniia,* vol. 8, Nov.-Dec. 1970, p. 855-861. 6 refs. In Russian.

Discussion of some aspects of controlling the L/D ratio of a reentry vehicle by varying the angle of attack. Particular attention is given to the possibility of controlling the angle of attack by varying the position of the vehicle's center of mass, and to the mechanical aspects of this process. Two schemes of varying the position of the center of mass are analyzed: one, where a spherical mass is displaced along vertical guide rails (or performs some other translational motion), and one, where a spherical mass whose center of inertia does not lie on the symmetry axis performs a rotation with respect to the vehicle's frame. V.P.

A71-16043 # **Determination of atmospheric parameters from the braking data of the Proton 2 satellite with allowance for its orientation (Ob opredelenii parametrov atmosfery po dannym o tormozhenii sputnika 'Proton-2' s uchetom ego orientatsii).** V. V. Beletskii, G. I. Zmievskaia, and M. Ia. Marov. *Kosmicheskie Issledovaniia,* vol. 8, Nov.-Dec. 1970, p. 889-895. 6 refs. In Russian.

Development of a method of determining the aerodynamic drag coefficient for a satellite of complex configuration, using measurements data of the actual orientation of the satellite in its motion about the center of mass. The method proposed makes it possible to improve the accuracy of determining atmospheric density variations. A model of the interaction between a rarefied gas flow and the satellite is constructed and is used for calculating the density of the thermosphere. The possible error involved in these calculations is assessed. V.P.

A71-16124 # **Centered two-dimensional nonequilibrium expansion flow in the hypersonic range (Die zentrierte zweidimensionale Nichtgleichgewichts-Expansionsströmung im Hyperschallbereich).** Klaus Hans Finke. Rheinisch-Westfälische Technische Hochschule, Mathematisch-Naturwissenschaftliche Fakultät, Dr.-Ing. Dissertation, 1970. 157 p. 89 refs. In German.

A theoretical analysis is made of a two-dimensional centered nonequilibrium expansion flow in the hypersonic range, allowing for coupled vibration and dissociation nonequilibrium. Equilibrium, partially frozen, and frozen expansion flows are considered as limiting cases. Since in the case of a real gas flow with chemical reactions the wall heat transfer depends essentially on the thermodynamic state of the gas in and outside of the boundary layer, the heat transfer for the three above-mentioned limiting cases is calculated numerically with the aid of the theory of dissociated laminar plate boundary layers. It is found that the wall heat flux allows unequivocal conclusions to be drawn regarding the local thermodynamic state of the gas outside of the boundary layer. In these boundary layer calculations no restrictions are placed on the Prandtl, Schmidt, and Lewis numbers, which are regarded as functions of the local values of temperature and pressure. In the lower hypersonic range an attempt is made to have the measurement section consist essentially of equilibrium flow. The nonequilibrium flow at the expansion corner is investigated with the aid of a Mach-Zehnder interferometer, piezoelectric pressure transducers, and platinum film thermometers. A.B.K.

A71-16128 **Test flight with the 'Standard-Elfe' (Testflug mit der Standard-Elfe).** Günter Cichon. *Deutscher Aerokurier,* vol. 14, Dec. 1970, p. 882-884. In German.

Discussion of a test flight conducted with the glider Elfe S-3 taking also into consideration certain problems which have now been solved in a new design, the Elfe S-4. Test conditions are examined and the performance of the glider is discussed. Certain imperfections in the design of the glider in connection with cockpit and wing are pointed out. The new Elfe S-4, which is free of these disadvantages, is described. G.R.

A71-16129 **Para-plane - The latest in international parachute design (Para-Plane - Das Neueste im internationalen Fallschirmbau).** Heinz Girnth. *Deutscher Aerokurier,* vol. 14, Dec. 1970, p. 900, 901. In German.

Discussion of the para-plane, a new parachute type which was designed by a U.S. aerospace company. The new design makes use of 'pilot chute controlled reefing' to center the pilot chutes in a low drag area. It is shown that the para-plane can easily reach a target well out of range of conventional parachutes. G.R.

A71-16131 **Hydraulics in wide-bodied jet aircraft (Hydraulik von Grossraumflugzeugen).** Rolf J. Dutzmann. *Flugrevue/Flugwelt International,* Jan. 1971, p. 32-34. In German.

Discussion of the hydraulics system in wide-bodied jet aircraft giving particular attention to the hydraulics in the Boeing 747. It is pointed out that the various types of new wide-bodied jet aircraft have in common aspects of an increased dependence on hydraulics. The advantages of the use of hydraulics are examined, and the design and the performance of a typical hydraulics system are discussed. The modern axial piston design is considered. G.R.

A71-16132 **Pöschel P-300 Equator, a STOL utility aircraft embodying a new concept (Pöschel P-300 Equator - STOL-Mehrzweckflugzeug einer neuen Konzeption).** Dietrich Seidl. *Flugrevue/Flugwelt International,* Jan. 1971, p. 35-39. In German.

Discussion of the Pöschel P-300 Equator, a light executive STOL amphibian providing standard accomodations for five or six persons. The single Lycoming T10-540 turbosupercharged six-cylinder air-cooled engine, mounted in the fuselage aft of the passenger cabin drives a two-blade tractor propeller mounted at the top of the vertical tail assembly. The P-300 Equator is capable of operating from water with a wave height of up to 1 m. G.R.

A71-16133 **Universal mini-carrier UMC-120, a light German STOL transport (Universal Mini-Carrier UMC-120, leichter deutscher STOL-Transporter).** Hans Brenner. *Flugrevue/Flugwelt International,* Jan. 1971, p. 40-43. In German.

Discussion of the UMC-120 project of a private German design team involving the design of a light STOL transport in five versions. A passenger version, a cargo version, an ambulance version, a paratroop version, and a utility version are considered. The UMC-120 is a braced high wing monoplane with a nonretractable tricycle type landing gear and two Garrett-AiResearch TPE-331-2 turboprop engines each driving a three-blade Hartzell propeller of 2.591 m diam. G.R.

A71-16135 **Possibilities of in-flight simulation of rotary wing and VTOL aircraft systems by means of a BO 105 helicopter (Möglichkeiten zur Simulation im Flug von Drehflüglern und Vertikalstart-Flugsystemen mit dem Hubschrauber BO 105).** K. Janik (Messerschmitt-Bölkow-Blohm GmbH, Ottobrunn, West Germany). *Luftfahrttechnik Raumfahrttechnik,* vol. 16, Nov.-Dec. 1970, p. 273-278. 14 refs. In German.

Discussion of the merits of in-flight simulation as a means for defining the controllability requirements of future high-performance helicopters and VTOL aircraft in accordance with the particular needs of their respective mission. It is shown that in-flight simulation offers unique possibilities of realistically reproducing the visual and kinetic impressions, as well as the various environmental conditions, which, apart from the aerodynamic characteristics of such aircraft, exert strong influence on the decisions of the pilot during hover and transition flight. The aerodynamic capabilities desirable in a simulating aircraft are reviewed and compared with the characteristics of the BO 105 helicopter, whose costs and safety features are then discussed. M.V.E.

A71-16136 Drop-forged and press-forged titanium alloy components in aeronautics (Schmiede- und Pressteile aus Titanlegierungen für die Luftfahrt). Klaus Rüdinger (Contimet GmbH, Krefeld, West Germany). *Luftfahrttechnik Raumfahrttechnik,* vol. 16, Nov.-Dec. 1970, p. 278-283. 15 refs. In German.

Review of the wide range of drop-forged and press-forged titanium alloy components used in airframes, jet engines, missiles, satellites and other aerospace materiel. The differing thermal and mechanical stresses these components must withstand are shown to lead to the application of a large variety of titanium alloys, whose properties are considerably influenced by the thermal and mechanical treatment they are subjected to. M.V.E.

A71-16139 State of development of turbojet propulsion plants - Statistical analysis of characteristic values (Entwicklungsstand der Turbostrahltriebwerke - Analyse einer Kenngrössen-Statistik). L. von Bonin (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Braunschweig, West Germany). *Luftfahrttechnik Raumfahrttechnik,* vol. 16, Nov.-Dec. 1970, p. 289-300. In German.

Description of the state of development of turbojet and turbofan engines through graphical compilation of comparative characteristic values. The selected graphic presentation of these characteristic values displays the interrelations among the various design and size parameters and provides therewith an insight into the underlying fundamentals, quite independently from any prevailing design philosophy. M.V.E.

A71-16141 Materials for aircraft of the 1990s (Werkstoffe für die Flugzeuge der 90er Jahre). A. A. Watts (Bell Aerospace GmbH, Bonn, West Germany). *Luftfahrttechnik Raumfahrttechnik,* vol. 16, Nov.-Dec. 1970, p. 304-306. In German.

Discussion of aircraft materials engineering trends in light of the stringent high-temperature strength demands of the age of supersonic air transportation. Some materials engineering problems of SST airframes and power plants are briefly reviewed, along with those of some aerospace vehicles. M.V.E.

A71-16237 Metallurgical characteristics of titanium-alloy foil prepared by electron-beam evaporation. H. R. Smith, Jr., K. Kennedy, and F. S. Boericke (Air Reduction Co., Inc., Airco Temescal Div., Berkeley, Calif.). *(American Vacuum Society, International Vacuum Metallurgy Conference, 2nd, Anaheim, Calif., June 15-19, 1970.) Journal of Vacuum Science and Technology,* vol. 7, Nov.-Dec. 1970, p. S48-S51.

Description of a continuous electron-beam vapor deposition process and analysis of the properties of Ti-6Al-4V alloy foils obtained by this process with respect to their use in honeycomb structures of a supersonic aircraft. It is shown that the properties of foils produced by electron-beam evaporation process on a moving substrate are equivalent to those of the rolled products. The foils easily meet the chemical and mechanical property requirements of aerospace specifications. Bend tests were shown to be superior to the rolled foil. The metallurgical characteristics were evaluated using optical micrography and electron micrography with replica, transmission, and scanning techniques. It was found that all metallurgical characteristics appear to be suitable for the intended end uses. Z.W.

A71-16275 Understanding and measuring vibrations. R. H. Wallace. London, Wykeham Publications (London), Ltd. (Wykeham Technological Series, No. 4), 1970. 158 p. 14 refs. $3.60.

The dynamics of vibrations is considered, with particular reference to the manner in which complex machines and their separate parts vibrate in practice. The nature of vibrations is explained, and a general survey of vibration measurement is presented. The main types of resonant and self-excited vibration patterns met with in aeroengines are then dealt with, followed by a discussion of forced vibrations both of the whole engine and accessories, as well as coupled vibrations. Typical measuring devices are reviewed, and a survey of their general application in vibration of parts and the whole engine is presented. Properties and limitations of various of the more common transducers used in engineering measurements are discussed. Finally, data reduction, analysis and replay, as well as sound room techniques are dealt with. O.H.

A71-16278 Effect of exhaust-nozzle shape on jet noise. Duvvuri Tirumalesa (Rohr Corp., Chula Vista, Calif.). *Acoustical Society of America, Journal,* vol. 48, Dec. 1970, pt. 1, p. 1327-1331. 7 refs.

Some salient results of an analysis based on Ribner's jet-noise model of experimental studies of the noise field of full-scale fitted with conical and eight-lobed daisy nozzles are presented in this note. The results show the effect of the exhaust-nozzle shape on the shear noise component of Ribner's model and importance of the noise contribution from the transitional region of the jet on the perceived noise levels (PNL). (Author)

A71-16286 # The dilemma of Air Force technology. Rufus D. Hutcheson (USAF, Washington, D.C.). *Air University Review,* vol. 22, Nov.-Dec. 1970, p. 26-34.

Discussion of short-term and long-term objectives of the Air Force technology program and their priorities. It is shown that the Air Force technology base is expanded in pursuit of two purposes, i.e., to satisfy near-term needs for particular capabilities and, at the same time, to achieve long-term incremental gains in fundamental technology areas which give promise of future utility. The dilemma to what extent the limited resources available should be directed toward either of these purposes is examined. Several areas of technology that currently offer significant exploration and application to systems engineering are discussed. Principal constraints on technology development are outlined. Several examples of systems development are presented.

A71-16325 The CADV of the Concorde - Valuable tool for the perfecting of the aircraft (Les CADV de Concorde - Outil précieux pour la mise au point de l'appareil). *Air et Cosmos,* vol. 8, Dec. 19, 1970, p. 32, 33, 45. In French.

Description of the automatic flight control system of the Concorde, which was conceived from the beginning as much more than a simple automatic pilot. Various modifications which have made it possible to reduce the weight of the automatic flight control from 165 kg on the prototype Concordes to 135 kg on the preproduction aircraft are described. The apparatus makes it possible to control the speed of the aircraft within a limit of 4 kt at Mach 2 at 50,000 ft. F.R.L.

A71-16346 Aluminum-reinforced epoxy models - A technique for preliminary design and stress analysis. E. I. Riegner (Boeing Engineering Laboratories, Philadelphia, Pa.) and A. E. Scotese (Photolastic, Inc., Malvern, Pa.). *(Society for Experimental Stress Analysis, Fall Meeting, Houston, Tex., Oct. 14-17, 1969.) Experimental Mechanics,* vol. 11, Jan. 1971, p. 38-45.

This paper discusses test applications, fabrication methods and stress-analysis techniques which have been developed on aluminum-filled epoxy models. The use of aluminum-reinforced epoxy models as a preliminary design tool has found extensive application in the development and modification of aircraft structures and related components. The range of uses has varied from the effects of adding or removing material in order to optimize a design, to a full experimental stress analysis of a complete part under multiple-loading conditions. This technique when used in conjunction with photoelastic coatings and/or strain gages, provides complete kinematic and design information before production, tooling,

manufacturing and engineering expenses are incurred. The paper discusses machined and molded models, material properties including time-modulus criteria and viscoelastic-creep phenomena, model rework, photoelastic-coating reinforcement and strain-gage effects. (Author)

A71-16347 Separation of radars on common frequencies by pulse-repetition-frequency discrimination. J. H. Blythe (Marconi Co., Ltd., Chelmsford, Essex, England). *Journal of Science and Technology*, vol. 37, no. 4, 1970, p. 157-162.

Discussion of an approach for drawing up a pulse-repetition-frequency plan to accommodate various choices of stagger of interpulse period in connection with the problem of the separation of radars on common frequencies. A brief outline of the operation of the pulse-repetition-frequency discrimination equipment is presented. Conditions for an output are examined, and conflict rules where one (or both) of the radars is double-staggered are investigated. A double-cancellation, double-stagger configuration and a double-cancellation, triple-stagger configuration are presented. The separation of interpulse periods for co-sited radars is discussed. Conflict rules for distant stations and channel extent are considered. G.R.

A71-16376 # Exact solutions to gasdynamics equations of the triple wave type (O tochnykh resheniiakh uravnenii gazovoi dinamiki tipa troinoi volny). A. F. Sidorov (Akademiia Nauk SSSR, Matematicheskii Institut, Sverdlovsk, USSR). *Akademiia Nauk SSSR, Doklady*, vol. 194, Oct. 1, 1970, p. 782-785. 7 refs. In Russian.

Derivation of a family of exact solutions to gasdynamics equations of the nonself-similar wave type. The solutions depend on three arbitrary functions of one argument and are applicable when the adiabat exponent in the equation of state is greater than 1 and smaller than 2. Flow fields produced by the interaction of three plane one-dimensional Riemann waves in a polytropic gas can be constructed by using these solutions. Classes of flows in which local collapses of potential motion are impossible are defined by an analysis of these solutions. The applicability of these solutions to a specific type of the equation of state is also noted. V.Z.

A71-16388 # An analysis of longitudinal control during landing approach. Norihiro Goto (Tokyo, University, Tokyo, Japan). *Japan Society for Aeronautical and Space Sciences, Transactions*, vol. 13, no. 22, 1970, p. 1-9. 16 refs.

Investigation of the characteristics of the back side operation using single and multiloop analyses. The problem of flight on the back side of the drag-velocity curve - i.e., one of the important problems in the landing approach - is examined assuming that it is a stability problem of the closed loop feedback control system where the pilot and the aircraft are regarded as elements. An analysis of this problem is made using the closed loop system analysis technique. It is shown that the system characteristics on the back side can be remarkably improved if the airspeed-control-with-throttle loop is added to the altitude-control-with-stick loop, and it is also shown that the lag in the throttle loop influences the system characteristics harmfully. A way of controlling the flight path on the back side is proposed as the result of the analysis. O.H.

A71-16397 # Existence and use of the singularity carrier auxiliary curve in airfoil cascades. O. Fűzy (Budapesti Müszaki Egyetem, Budapest, Hungary). *Periodica Polytechnica, Mechanical Engineering*, vol. 14, no. 3, 1970, p. 287-302. 6 refs.

Derivation of a generalized modification of the singularity methods based on the concept of an auxiliary carrier curve and used in designing airfoil cascades. Theorems are formulated and proved to demonstrate the existence of a generalized singularity carrier (or singularity carrier auxiliary curve) in an airfoil cascade. Procedures are also discussed for calculations in designing airfoil cascades with the aid of such singularity carrier auxiliary curves. V.Z.

A71-16487 # Concorde - Progress towards certification. S. G. Corps (Air Registration Board, London, England). *Tech Air*, vol. 27, Jan. 1971, p. 2-6, 8-11, 13, 14; Discussion, p. 14, 15, 17, 18.

Discussion of some aspects of flying a slender delta transport aircraft giving attention also to the background of the Concorde in the Air Registration Board (ARB). Airworthiness requirements for the SST are examined, and ARB participation in the flight test program is considered. An interesting aspect of development flying is discussed. Some preflight impressions regarding the flight deck and the instrument panel of the slender delta transport aircraft are reported, and flight experience in takeoff and landing operations is discussed. Special problems are examined including the static stability at high incidence. G.R.

A71-16520 Structure and propagation of detonations in gaseous mixtures in supersonic flow. J. C. Bellet and G. Deshayes (Ecole Nationale Supérieure de Mécanique et d'Aérotechnique, Poitiers, France). *(International Colloquium on Gas Dynamics of Explosions, 2nd, Novosibirsk, USSR, Aug. 24-29, 1969.) Astronautica Acta*, vol. 15, Nov. 1970, p. 465-469. Research supported by the Centre National de la Recherche Scientifique.

Experiments on spark ignited hydrogen-oxygen detonations were carried out in a 20 mm x 20 mm cross section supersonic wind tunnel, with observations performed by means of high speed schlieren photographs including cinematographic records. The results lead us to the following conclusions: (1) the detonation structure is multidimensional, consisting of a normal wave in the axial part of the test section surrounded by four oblique waves generated upstream in the boundary layer along the walls; (2) the area of the oblique waves increases and the normal wave area decreases with increasing flow Mach number; (3) the normal velocity with respect to the fresh gas, D, increases at first, and then becomes stabilized at a value which is always higher than the corresponding Chapman-Jouguet velocity D sub CJ, the difference D-D sub CJ increasing with M up to 15 per cent of D sub CJ for M equals 3.5. (Author)

A71-16531 Atomization processes and ignition criteria for supersonic combustion with liquid fuel injection. Forman A. Williams (California, University, La Jolla, Calif.). *(International Colloquium on Gas Dynamics of Explosions, 2nd, Novosibirsk, USSR, Aug. 24-29, 1969.) Astronautica Acta*, vol. 15, Nov. 1970, p. 547-557. 63 refs. Contracts No. AF 44(620)-68-C-0045; No. AF 44(620)-68-C-0010.

Consideration of liquid jet atomization, the results of which indicate that the acceleration wave mechanism is primarily responsible for jet disintegration under typical conditions in the combustion chamber of a supersonic-combustion ramjet engine. This observation is used to obtain a simple expression for the jet breakup time, which in turn is used to develop a simple formula defining necessary conditions for spontaneous ignition in the motor. The formula is in agreement with available experimental results. A more general ignition criterion is also stated. The results do not suggest that the capillary-wave and steady-shear breakup mechanisms do not occur, but rather that the acceleration-wave mechanism is faster at the high accelerations experienced by jets in high speed flows, and that therefore this mechanism is responsible for disintegration of most of the mass of the liquid. F.R.L.

A71-16562 # Rarefied hypersonic flow about cones and flat plates by Monte Carlo simulation. F. W. Vogenitz and G. Y. Takata (TRW Systems Group, Redondo Beach, Calif.). *(American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, San Francisco, Calif., June 16-18, 1969, Paper 69-651.) AIAA Journal*, vol. 9, Jan. 1971, p. 94-100. 28 refs. ARPA-supported research; Contract No. AF 04(701)-69-C-0119.

Study of rarefied hypersonic flow about slender cones and flat plates by a Monte Carlo simulation, in which the flow of a representative set of molecules past a body is followed by digital

computation, while molecular collisions are computed by statistical sampling. Calculations were made for Mach numbers of approximately 10 and 25 for both hot- and cold-wall conditions. Cone semiapex angle ranged from 3.0 to 15.0, while the ratio of ambient mean free path to body length was varied from .01 to 3.0. Properties in the flowfield and on the body surface are presented for a monatomic gas. The effects of the molecular collision model and surface interaction law are discussed. A comparison is made between these results and experimental data. (Author)

A71-16563 # **Starting phenomena in a supersonic tube wind tunnel.** J. A. Johnson, III (Southern University, Baton Rouge, La.) and D. Cagliostro. *AIAA Journal*, vol. 9, Jan. 1971, p. 101-105. 8 refs. Contract No. AF 40(600)-1133.

An experimental study has been performed of the unsteady processes in the starting period of a supersonic Ludwieg tube, a device which operates like an intermittent supersonic wind tunnel. A quick opening diaphragm located downstream of the nozzle initiates the flow. Pressure and density measurements are made in a variety of ways in Mach number 1.67 and 3.0 nozzles. For the starting conditions treated, supersonic flow is established in the nozzle without producing shock waves. Various time dependent functions are observed in the adjustment of gasdynamic parameters to their steady supersonic values. These changes of pressure, etc., include undershoots, overshoots, and other variations of the final steady-state values. Calculations based on an assumed zero-length nozzle do not adequately predict starting times and pressures. (Author)

A71-16564 # **Tip vortex effects on oscillating rotor blades in hovering flight.** W. P. Jones and B. M. Rao (Texas A & M University, College Station, Tex.). *AIAA Journal*, vol. 9, Jan. 1971, p. 106-113. 15 refs. Grant No. DA-HC-04-69-C-0015.

Investigation of the validity of the assumptions of two-dimensional strip theory used in rotor blade flutter studies regarding the justification to neglect tip vortex effects. Results are obtained which reveal to what extent the assumptions made are acceptable. From the general theory developed, it is concluded that up to tip Mach numbers of about 0.8, the use of two-dimensional strip theory would not lead to serious error provided the blades oscillate at several cycles per rotation. This general conclusion is derived on the basis of a comparison of the downwash induced at points along the blade as given by the usual two-dimensional theory and the corresponding values derived by an improved method which takes tip effects into account. G.R.

A71-16565 # **Calculation of plane steady transonic flows.** Earll M. Murman (Boeing Scientific Research Laboratories, Seattle, Wash.) and Julian D. Cole (California, University, Los Angeles, Calif.). *(American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 8th, New York, N.Y., Jan. 19-21, 1970, Paper 70-188.) AIAA Journal*, vol. 9, Jan. 1971, p. 114-121. 14 refs.

Steady transonic flow past thin airfoils is formulated using small disturbance theory. The governing transonic potential equation is a nonlinear mixed (elliptic-hyperbolic) differential equation. A boundary value problem is formulated and an analytical far field solution derived. For the near field a mixed finite difference system is developed to solve the transonic equation including cases with imbedded shock waves. Results are presented for nonlifting circular arc airfoils and a Nieuwland airfoil. Agreement with experiment for the circular arc airfoils, and exact theory for the shock free Nieuwland airfoil is excellent. (Author)

A71-16566 * # **Nongray radiating flow about smooth symmetric bodies.** W. B. Olstad (NASA, Langley Research Center, Gas Physics Section, Hampton, Va.). *(American Institute of Aeronautics and Astronautics, Thermophysics Conference, 4th, San Francisco, Calif., June 16-18, 1969, Paper 69-637.) AIAA Journal*, vol. 9, Jan. 1971, p. 122-130. 17 refs.

Modification of a simplified flowfield technique developed by Maslen (1964) to account for radiation and large blowing. Radiation cooling and nongray absorption (including the contribution of atomic lines) were taken into account. Results were obtained for a series of blunted cones traveling at speeds from 10.7 to 15.2 km/sec at an altitude of 60.96 km in the earth atmosphere. It is shown that the radiative heating distributions depend strongly on whether the primary source of radiation is the entropy layer or the flow external to the entropy layer. It is also shown that the entropy layer can be significantly affected by radiation cooling. The reduction of radiative heating by blowing cold air from the body surface is also discussed. (Author)

A71-16581 # **Turbulent boundary-layer flow over a rotating flat-plate blade.** W. J. McCroskey (U.S. Army, Aeronautical Research Laboratory, Moffett Field, Calif.), J. F. Nash, and J. G. Hicks (Lockheed-Georgia Research Laboratory, Marietta, Ga.). *AIAA Journal*, vol. 9, Jan. 1971, p. 188, 189.

Discussion of a set of calculated results for the incompressible turbulent flow over a steadily rotating flat-plate blade. Flow conditions which in the laminar case were found by Dwyer and McCroskey (1970) to produce strong three-dimensional effects, such as centrifugal pumping and an increase in the shear stress at the wall are considered. Particular attention is given to the extent to which certain qualitative features of laminar and turbulent flows are alike. G.R.

A71-16582 # **Turbulent boundary-layer separation at low supersonic Mach numbers.** Robert E. Wilson (USAF, Washington, D.C.) and Franz Maurer (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Porz-Wahn, West Germany). *AIAA Journal*, vol. 9, Jan. 1971, p. 189, 190.

Discussion of turbulent boundary-layer separation at low supersonic Mach numbers, taking into consideration tests performed in a blowdown wind tunnel having a 60 x 60 cm rectangular test section. It was found that separation distance becomes an increasingly strong function of Mach number as the Mach number is decreased below 2, increasing with decreasing Mach number. It is pointed out that measured plateau pressure coefficients are most accurately described by a correlation due to Werle (1968) but are also quite accurately predicted by the simpler correlation of Zukoski (1967). G.R.

A71-16647 # **Further study of pure-impulse high-camber, high-solidity axial compressors.** Bolesław Szczeniowski (Montréal, Université, Montreal, Canada). *Archiwum Budowy Maszyn*, vol. 17, no. 3, 1970, p. 347-374.

By contrast with the previous paper, which was devoted to the single-stage compressor with subsonic relative air velocity through the impeller, the subject of the present paper is the two-stage compressor. Subsonic and supersonic relative air velocity are considered. The paper includes the computation of a two-stage compressor with subsonic and supersonic air velocity and high-camber rotor blades together with the strength computation and a discussion of the form of the rotor and diffuser blades of a supersonic compressor. In his concluding remarks the author states that the same method can be applied to an axial impulse turbine with dense blades and expresses the opinion that a combination of a two-stage compressor and a two-stage turbine may give an efficiency reaching 47 percent. (Author)

A71-16666 # **Airplane measurements of planetary boundary layer structure.** D. H. Lenschow (National Center for Atmospheric Research, Boulder, Colo.). *Journal of Applied Meteorology*, vol. 9, Dec. 1970, p. 874-884. 16 refs.

Measurements of air velocity and temperature from an airplane in the planetary boundary layer with strong surface heating are used to calculate vertical heat, momentum and energy fluxes, as well as

spectral densities and probability distributions of velocity and temperature. Airplane traverses parallel to the wind are compared to crosswind traverses and a definite elongation of the heat transporting eddies, or thermals, parallel to the wind is observed. The terms in the turbulent kinetic energy balance equation (with the exception of the pressure fluctuation term) and the temperature variance balance equation are estimated. The turbulent kinetic energy dissipation is almost constant with height between the lowest flight level of 100 m above the surface, and the highest flight level of 1000 m, which is just below the top of the boundary layer, while the generation term due to the buoyancy force decreases and the divergence of the vertical transport of kinetic energy increases with height to maintain an approximate balance. The temperature variance dissipation decreases rapidly with height and the generation of temperature variance and the divergence of the vertical transport of temperature variance become small above 100 m. (Author)

A71-16680 **Flying the lifting bodies.** William H. Dana and Gerauld Gentry. *Flight International,* vol. 98, Dec. 31, 1970, p. 1016-1020.

Discussion of the impressions of two pilots of vehicles which had been built in order to investigate the low-speed handling of hypersonic vehicles in preparation for advanced transports such as the space shuttle. The pilot Dana describes approach and landing operations for the M2-F3, HL-10, and X-24A lifting bodies. Some details regarding the landing pattern are given by Gentry. Aspects of stability and flight handling are also discussed. G.R.

A71-16700 # **Validity of reported extreme wind speeds in the arctic stratosphere at SST altitudes.** D. D. Grantham and A. J. Kantor (USAF, Cambridge Research Laboratories, Bedford, Mass.). *American Meteorological Society, Bulletin,* vol. 51, Dec. 1970, p. 1121-1124. 5 refs.

Investigation of extreme wind speeds which have been reported in the arctic stratosphere over Alaska, Greenland, and Eurasian arctic regions. The following three facts have been established concerning the occurrence of very strong rawinsonde-reported winds in the arctic stratosphere above 20 km: first, horizontal temperature gradients in the Canadian arctic determined from the thermal wind relationship are at least 50% greater than the observed temperature gradients over distances of 150 to 300 mi; second, subsequent to equipment and procedural changes made in the Canadian upper-air sounding system during 1966 and 1967, extremely high wind speeds no longer appear in the records; and, finally, almost all extreme winds over all areas, Canada, Alaska, Greenland, and Eurasia, were reported at or near the termination level and/or very close to the critical elevation angle for the rawinsonde tracking systems. O.H.

A71-16711 **Slender rod in shear flow.** Torstein K. Fannelop and Peter C. Smith (Avco Corp., Avco Systems Div., Wilmington, Mass.). *Zeitschrift für angewandte Mathematik und Physik,* vol. 21, Nov. 25, 1970, p. 918-940. 16 refs.

Analytical study of the boundary layer development about a long thin rod in axial flow, in an environment characterized by velocity and enthalpy gradients in the radial direction. Two different inviscid shear-flow profiles are considered - a shear region of infinite lateral extent and a shear layer of finite width. The analytical solutions for both cases are expressed in terms of exponential functions and integrals. M.V.E.

A71-16712 **Supersonic boom and drag of a pointed-nose body of revolution in a gravitationally stratified atmosphere (Überschallknall und Widerstand eines vorne spitzen Rotationskörpers in einer schweregeschichteten Atmosphäre).** Roland Stuff (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Institut für theoretische Gasdynamik, Aachen, West Germany). *Zeitschrift für angewandte Mathematik und Physik,* vol. 21, Nov. 25, 1970, p. 940-946. 11 refs. In German.

Assessment of the validity range of Ryhming's (1961) conclusion that the minimum-boom body for a given bow-shock wave drag is also the minimum drag body. It is shown that this conclusion is valid only for asymptotic distances. The geometry of the minimum-boom body depends on the distance for which one wants to minimize the sonic boom. M.V.E.

A71-16713 **Supersonic flow about a flat plate at an angle of attack (Die Überschallumströmung der angestellten, ebenen Platte).** Franz Durst (Imperial College of Science and Technology, London, England) and Kurt Brieden. *Zeitschrift für angewandte Mathematik und Physik,* vol. 21, Nov. 25, 1970, p. 947-962. 5 refs. In German.

Evaluation of two supersonic flow approximation methods in the light of exact numerical calculation results covering the properties of supersonic flow about a flat plate set at angles of attack over an incidence range allowing supersonic flow to exist throughout the whole flow field. The evaluation results show Brieden's (1955) approximation method to be able to describe both qualitatively and quantitatively the flow behavior, whereas Lighthill's (1944) approximation technique appears to be only qualitatively effective. Some other insights provided by the results obtained are described and discussed. M.V.E.

A71-16734 # **Direct shear-force measurement on small surface elements (Mesure directe de la force de frottement sur de petits éléments de surface).** Hubert Bougon and Jean Pontézière. *La Recherche Aérospatiale,* vol. 139, Nov.-Dec. 1970, p. 325-327. 10 refs. In French.

Measurement of the local skin friction along the wall during laminar or turbulent flow, using a sensor developed by Chevalier (1967). The characteristics of the sensor used are presented, and some results obtained in a supersonic wind tunnel at Mach number 16 are described. Z.W.

A71-16735 # **Analog determination of transonic wing profiles by the hodograph method (Détermination analogique de profils d'ailes transsoniques par la méthode de l'hodographe).** André Bouveret. *La Recherche Aérospatiale,* vol. 139, Nov.-Dec. 1970, p. 327-329. In French.

Description of the Rigaut (1968) hodograph method presently in use at the ONERA laboratory for determining transonic wing profiles. The method is also applicable to the domain of subsonic compressible flows and is economical in that it is workable with most standard equipment. A few specific examples are used for illustrating the wing profile determination procedure. M.V.E.

A71-16736 # **A short response-time analog periodmeter (Un périodemètre analogique à court temps de réponse).** Jean Eischen. *La Recherche Aérospatiale,* vol. 139, Nov.-Dec. 1970, p. 330. In French.

Description of the design of a periodmeter for studying vibrations of helicopter blades. The periodmeter is composed of a short-time constant integrator, sampler, and different circuits which depend on the nature of initial pulses. The block diagram of the device is presented, and possible applications of this periodmeter to other problems are discussed. Z.W.

A71-16737 # **Complementary results at reduced high frequencies pertaining to the unsteady C sub p coefficients induced by the rotation of a control surface in incompressible flow (Résultats complémentaires à grandes fréquences réduites relatifs à des C sub p instationnaires induits par la rotation d'une gouverne en incompressible).** Roger Destuynder. *La Recherche Aérospatiale,* vol.

139, Nov.-Dec. 1970, p. 331-334. In French.

Review of some of the results of a test series aimed at unsteady coefficient measurements and performed jointly with the Royal Aircraft Establishment. The purpose of this joint effort was to provide experimental data for the corroboration of a theory developed by ONERA on the unsteady coefficient distribution about little elongated two-dimensional wings with control surfaces. So far, the experimental results obtained show only in part good agreement with theory-based calculations. M.V.E.

A71-16750 Effect of inlet conditions on the effectiveness of cone-shaped diffusers. O. I. Didenko and A. P. Stepanenko (Akademiia Nauk Ukrainskoi SSR, Institut Technicheskoi Teplofiziki, Kiev, Ukrainian SSR). (*Energetika,* vol. 6, 1970, p. 102-106.) *Heat Transfer - Soviet Research,* vol. 2, Nov. 1970, p. 65-68. 13 refs. Translation.

Results of experiments with diffusers with opening angles of 6 to 60 deg and expansion ratios of 1.5 to 6. The flow at the diffuser inlets was turbulent (Re greater than one million) and the Mach number was in the range from 0.3 to 0.9; the turbulence at the axis did not exceed 0.5%. The effect of the initial boundary-layer thickness and the Mach number on the pressure recovery coefficient was considered. It is shown that the boundary layer has a negative effect on the diffuser effectiveness up to angles of 30 to 40 deg. The effect of compressibility appears all the sooner, the larger the diffuser angle and the thicker the inlet boundary layer. (Author)

A71-16753 # Equivalent test program for gas-turbine engines (Programma ekvivalentnykh ispytanii gazoturbinnykh dvigatelei). N. D. Kuznetsov and V. I. Tseitlin. *Problemy Prochnosti,* vol. 2, Oct. 1970, p. 14-19. In Russian.

Analysis of factors affecting the service life of gas-turbine engine components, on the basis of modern concepts concerning the summation of material defects under the action of physical and thermal static and variable loads. Formulas for evaluating the equivalent service life of materials and components are proposed. V.P.

A71-16754 # Statistical evaluation of the heat-resistance characteristics of gas-turbine engine materials. II - Change in the dispersion of fatigue-life and creep characteristics as a function of temperature and test duration (Statisticheskaia otsenka kharakteristik zharoprochnosti materialov dlia gazoturbinnykh dvigatelei. II - Izmenenie dispersii kharakteristik dlitel'noi prochnosti i polzuchesti v zavisimosti ot temperatury i dlitel'nosti ispytaniia). I. P. Bulygin, N. I. Parfenova, L. N. Timofeeva, and I. I. Trunin (Vsesoiuznyi Nauchno-Issledovatel'skii Institut Aviatsionnykh Materialov, Moscow, USSR). *Problemy Prochnosti,* vol. 2, Oct. 1970, p. 20-24. In Russian.

Discussion of fatigue and creep tests performed with two nickel-base turbine-engine alloys (EP109VD and EI961) at operational temperatures and durations from 100 to 10,000 hr. The laws governing the changes in the dispersion of heat-resistance characteristic are determined as a function of the temperature and service life. The laws obtained make it possible to increase the reliability of strength and performance estimates for turbine-engine materials. V.P.

A71-16756 # Computational method for evaluating the endurance of gas-turbine engine nozzle guide vanes under pulsed thermal modes of operation (Raschetnyi metod otsenki prochnosti soplovykh lopatok GTU pri impul'snykh teplovykh rezhimakh). L. B. Getsov, Iu. D. Martynov, Iu. S. Osherov, V. A. Plekhanov, E. P. Rivlin, and A. D. Trukhnii. *Problemy Prochnosti,* vol. 2, Oct. 1970, p. 34-37. In Russian.

Development of a method of evaluating the service life of solid and hollow turbine guide vanes, which is based on calculating the heat transfer coefficients and the temperature and stress fields, and evaluating the heat resistance of the vanes. The possibility of increasing the service life of uncooled vanes by optimal selection of the cavity geometry is demonstrated. V.P.

A71-16757 # Statistical analysis of the fatigue characteristics of light alloys for obtaining probabilistic estimates of the endurance of aircraft structural elements (Statisticheskii analiz ustalostnykh kharatekteristik legkikh splavov dlia veroiatnostnoi otsenki prochnosti elementov aviakonstruktsii). M. N. Stepnov, E. V. Giatsintov, and A. S. Seregin. *Problemy Prochnosti,* vol. 2, Oct. 1970, p. 38-42. In Russian.

Analysis of the fatigue characteristics (obtained in laboratory tests) of aircraft alloys and of their applicability to the evaluation of component endurance. It is shown that for samples of various dimensions and stress concentrations, there exists a common fatigue curve in relative coordinates. Using this curve, the fatigue characteristics of structural elements can be determined on the basis of test data. V.P.

A71-16761 # Equivalent testing of gas turbine engines (Ekvivalentnye ispytaniia gazoturbinnykh dvigatelei). N. D. Kuznetsov. *Problemy Prochnosti,* vol. 2, Oct. 1970, p. 74-77. In Russian.

Discussion of possibilities of shortening the test time required to increase the service life of aircraft engines. It is proposed to conduct an equivalent test along a program constructed on the basis of an analysis of factors which influence the service life of the individual units and components of an engine. Factors which affect the service life of engine components and lend themselves to quantitative evaluation include failure by fatigue, creep, stress relaxation, heat resistance, wear, and contact endurance. Special tests (not included in equivalent testing) should be conducted to determine the influence on service life of such factors as fuel and lubricant coking, erosion and contamination of components, and random accidental damage (such as of blade edges). V.P.

A71-16798 # On pure impulse compressors - A means for preventing surge. Bolesław Szczeniowski (Montréal, Université, Montreal, Canada). *Archiwum Budowy Maszyn,* vol. 17, no. 4, 1970, p. 563-567.

In this paper a means for preventing surge, applicable to a two-stage compressor, is proposed in the form of a differential coupling between two stages, enabling a variable ratio of rotational velocities of the two impellers to be obtained, this ratio being adjusted automatically in response to any imposed airflow rate. (Author)

A71-16848 # Conditions of existence and longitudinal dimensions of the recirculation zones in an interaction between a supersonic jet and a bounded subsonic wake (Usloviia sushchestvovaniia i prodol'nye razmery retsirkuliatsionnykh zon pri vzaimodeistvii sverkhzvukovoi strui s ogranichennym sputnym dozvukovym potokom). L. A. Bakaldina and I. V. Sidorov (Akademiia Nauk SSSR, Institut Teoreticheskoi i Prikladnoi Mekhaniki, Novosibirsk, USSR). *Akademiia Nauk SSSR, Sibirskoe Otdelenie, Izvestiia, Seriia Tekhnicheskikh Nauk,* June 1970, p. 37-45. In Russian.

Experimental determination of the boundaries (the longitudinal dimensions) of the recirculation zones arising during an interaction between a supersonic jet source and a bounded subsonic wake. The conditions of formation and the dimensions of the recirculation zones in a channel of constant cross section with an essentially subsonic mean velocity are determined with the aid of a modified Craya-Curtet parameter which takes into account the different densities of the mixing flows. The critical values of the similarity parameter as determined from the profile in the transition cross section and from measurements of the boundaries of the recirculation region are presented. A.B.K.

A71-16849 # Stability of an incompressible boundary layer (Ustoichivost' neszhimaemogo progranichnogo sloia). A. G. Volodin and S. A. Gaponov (Akademiia Nauk SSSR, Institut Teoreticheskoi i Prikladnoi Mekhaniki, Novosibirsk, USSR). *Akademiia Nauk SSSR, Sibirskoe Otdelenie, Izvestiia, Seriia Tekhnicheskikh Nauk,* June

1970, p. 55-58. 8 refs. In Russian.

Study of the stability of incompressible boundary layers on straight and yawing wings with a single-term power-law velocity distribution at the outer boundary of the layer. Using a numerical method based on the method of Gol'dshtik and Sapozhnikov (1968), some calculations performed by Pretsch (1942) are repeated, and more complete data than those obtained by Brown (1961, 1964) are obtained concerning the stability of the boundary layer on a yawing wing in the face of perturbations propagating in the direction of the normal to the streamline of the external flow. A.B.K.

A71-16850 # **Stability of the velocity profiles of a Pohlhausen family (Ustoichivost' profilei skorosti semeistva Pol'-gauzena).** A. G. Volodin and S. A. Gaponov (Akademiia Nauk SSSR, Institut Teoreticheskoi i Prikladnoi Mekhaniki, Novosibirsk, USSR). *Akademiia Nauk SSSR, Sibirskoe Otdelenie, Izvestiia, Seriia Tekhnicheskikh Nauk,* June 1970, p. 59-61. In Russian.

Study of the stability of a boundary layer with velocity profiles given by a Pohlhausen polynomial of sixth degree. On the basis of numerical integration of the Orr-Sommerfeld equation a calculation is made of the stability of a three-dimensional boundary layer on a yawing wing with velocity profiles in the range of the parameter lambda from -500 to +500. A.B.K.

A71-16852 # **Calculation of the conditions of stabilization by cooling of a supersonic boundary layer on a plate in the case of exactly formulated boundary conditions for the temperature perturbations (Raschet uslovii stabilizatsii okhlazhdeniem sverkhzvukovogo pogranichnogo sloia na plastine pri tochnoi postanovke granichnykh uslovii dlia temperaturnykh vozmushchenii).** A. S. Dryzhov (Akademiia Nauk SSSR, Institut Teoreticheskoi i Prikladnoi Mekhaniki, Novosibirsk, USSR). *Akademiia Nauk SSSR, Sibirskoe Otdelenie, Izvestiia, Seriia Tekhnicheskikh Nauk,* June 1970, p. 69-74. 6 refs. In Russian.

Calculation of the critical values of the surface temperature of a plate in the case of stabilization by cooling of a supersonic boundary layer with respect to infinitesimally small two-dimensional perturbations. The calculation is performed for the boundary conditions obtained by Dunn and Lin (1955). It is shown that, although the stabilization range is unique for all Mach numbers in the case of exactly formulated boundary conditions for the temperature perturbations, the change in the critical Reynolds number apparently occurs nonmonotonically. A.B.K.

A71-16892 # **Contribution to slender profile theory in magnetohydrodynamics (Do teorii tonkogo profiliu v magnitnii gidrodinamitsi).** V. I. Putiata and G. B. Sher'iazdanov (Kiivs'kii Derzhavnii Universitet, Kiev, Ukrainian SSR). *Akademiia Nauk Ukrains'koi RSR, Dopovidi, Seriia A - Fiziko-Tekhnichni i Matematichni Nauki,* vol. 32, Oct. 1970, p. 927-930. In Ukrainian.

Discussion of the flow at a small angle of incidence of an incompressible conducting fluid past a slender nonconducting profile in the presence of a magnetic field. A solution of the system of magnetohydrodynamic equations with given boundary conditions is sought in the form of an asymptotic expansion of the required functions in powers of a small parameter defining the geometry of the profile. A recursion system of linear differential equations is derived, and the boundary conditions for the magnetic field components are determined. V.P.

A71-16900 # **Theoretical and experimental investigations of ignition and combustion processes in rapidly flowing gas mixtures especially in the supersonic range (Theoretische und experimentelle Untersuchungen von Zündungs- und Verbrennungsvorgängen in schnellströmenden Gasgemischen, insbesondere im Überschallbereich).** Eberhard Plassmann. Rheinisch-Westfälische Technische Hochschule, Fakultät für Maschinenwesen, Dr.-Ing. Dissertation, 1969. 175 p. 131 refs. In German.

Discussion of theoretical studies conducted to obtain information regarding the parameters of ramjets for various combustion processes and of an experimental investigation designed to provide data for supersonic combustion problems. Theoretical foundations for the calculation of the heating of supersonic flows are examined. Numerical calculations of the parameters of ramjets with supersonic combustion are presented taking into consideration geometric factors and dissociation effects for expansion hypotheses of the chemical equilibrium and the frozen flow. An experimental investigation of the ignition and combustion of previously mixed rapidly flowing gases with the aid of pilot flames is discussed. G.R.

A71-16954 # **The NAE airborne V/STOL simulator as a design and development tool for V/STOL aircraft.** W. S. Hindson (National Aeronautical Establishment, Ottawa, Canada). *(Canadian Aeronautics and Space Institute, Flight Test Symposium, Ottawa, Canada, Feb. 7, 1970.) Canadian Aeronautics and Space Journal,* vol. 16, Dec. 1970, p. 413-419. 12 refs.

An airborne simulator is a useful design tool in the development of new aircraft, enabling realistic in-flight assessment of anticipated or proposed design characteristics even prior to the existence of a prototype. The NAE variable stability helicopter has been used in this fashion for several different vehicles of the V/STOL class, notably the Canadair CL-84 Tilt-Wing V/STOL aircraft and, more recently, the proposed De Havilland DHC-7 STOL transport. In addition, the simulator is useful as a safe and flexible development tool for existing V/STOL designs, as in the case of the Hawker-Siddeley P1127, allowing a comprehensive handling qualities investigation of various stability augmentation systems for that aircraft. Work undertaken at the Flight Research Section of the National Aeronautical Establishment as applied to these and other specific V/STOL designs is reviewed, with particular emphasis on the flight test technique in obtaining solutions to design problems.

(Author)

A71-16960 # **Wake curvature and the Kutta condition.** D. A. Spence (Wisconsin, University, Madison, Wis.). *Journal of Fluid Mechanics,* vol. 44, Dec. 16, 1970, p. 625-636. 13 refs. Contract No. DA-31-124-ARO(D)-462.

Investigation of the problem of where the sources representing the displacement of a wake should be located in a potential-flow calculation. The potential problem for the flow at high Reynolds numbers outside the boundary layer and wake of a thin flat plate at small incidence with allowance for displacement thickness is considered. It is shown that this problem cannot be fully defined unless the position of the wake is known in advance. It is further shown that the Kutta-Joukowski hypothesis does not provide a satisfactory first approximation to this because of the singularity in curvature of the streamline springing from the trailing edge in inviscid flow, which implies that the initial curvature of the wake in the real flow will be large enough to cause a modification to the potential flow. To find a solution to this problem, the Navier-Stokes equations are written in curvilinear coordinates to permit calculation of the vorticity. The turbulent terms are retained, but it is argued that they do not affect the vorticity-curvature relationship, except indirectly through the momentum thickness. The potential problem for the outer flow is then formulated, leading to an integrodifferential equation for the slope of the wake streamlines. A coordinate stretching transformation is found which displays the balance between vorticity and curvature in both inner and outer flows. The circulation around an infinite contour, which gives the lift on the wing, is found from the solution of the integral equation. The features of the solution are examined. O.H.

A71-16961 # **Turbulent boundary-layer wall-pressure fluctuations on smooth and rough walls.** William K. Blake (U.S. Naval Material Command, Naval Ship Research and Development Center,

Washington, D.C.). *Journal of Fluid Mechanics*, vol. 44, Dec. 16, 1970, p. 637-660. 18 refs. Contract No. N 00014-67-A-0204-0002.

Experimental investigation of turbulent boundary-layer wall-pressure spectra on hydrodynamically smooth and rough surfaces, carried out in a subsonic low-turbulence acoustic wind tunnel by means of special microphones with an outstanding high-frequency resolution. The influence of high-frequency eddies on smooth-wall pressure statistics was first examined. It was found that the space-time decay rate is considerably higher than that measured previously. Measurements of cross-spectral density made with 5 Hz bandwidth filters disclosed low phase speeds at low frequency and small separation. Measurements were repeated on rough walls and parallels were drawn from knowledge of a smooth-wall boundary-layer structure to propose a structure for a rough-wall boundary layer. The effect of independently varying roughness and separation on the large and small-scale turbulence structure was deduced from the measurements. It was found that roughness separation affected the very large-scale structure, whereas the roughness height influenced the medium and very small-scale turbulence. O.H.

A71-16964 # **An experimental study of non-linear interaction of velocity fluctuations in the transition region of a two-dimensional wake.** Hiroshi Sato (Tokyo, University, Tokyo, Japan). *Journal of Fluid Mechanics*, vol. 44, Dec. 16, 1970, p. 741-765. 9 refs.

Experimental study of the laminar-turbulent transition of a two-dimensional wake, with particular emphasis on the nonlinear interaction of velocity fluctuations. An attempt is made to clarify the nonlinear interaction and the randomization process experimentally. Detailed measurements were made on mean and fluctuating velocities in the wake with two different initial conditions. One is the natural transition without artificial disturbances. The other is the transition in the presence of sound from a loudspeaker. The sound induces a small-amplitude velocity fluctuation in the wake. The fluctuation is amplified in the linear region, if the frequency is properly chosen. Using a sound composed of two frequencies, the nonlinear interaction of two velocity fluctuations was investigated. Randomizations of regular velocity, which lead to the development of turbulence, were observed by spectral analysis. The results are discussed and analyzed. O.H.

A71-16965 • # **Interaction of grid turbulence with a uniform mean shear.** W. G. Rose (*Virginia, University, Charlottesville, Va.*). *Journal of Fluid Mechanics*, vol. 44, Dec. 16, 1970, p. 767-779. 8 refs. NSF Grant No. GU-1022; Grants No. AF AFOSR 1078-67; No. NsG-682.

Experimental study of the effect of initial disturbance length-scale on turbulence developed in the presence of a uniform mean shear. Flows with nearly the same mean shear and initially different turbulent scales are generated in a wind tunnel test section by placing grids just downstream of a honeycomb of uniform cell diameter and nonuniform cell length. Both round-rod grids of uniform square mesh and parallel-rod construction with roughly equal solidity are used. From the results it is concluded that for a given value of mean shear the imposed length scale fixes the energy level of the resulting turbulence, provided the scale is sufficiently large. Also, it is found that two-dimensional flow-generator geometries are more effective than three-dimensional geometries in producing a roughly homogeneous turbulent field with a higher fluctuation level in a shorter distance. O.H.

A71-17106 # **Changes of state of highly-energetic propellant-oxidizer systems in the range of high temperatures taking into consideration chemical relaxation (Zustandsänderungen hochenergetischer Treibstoff-Oxidator-Systeme im Bereich hoher Temperaturen unter Berücksichtigung der chemischen Relaxation).** Manfred Schaffrath. Rheinisch-Westfälische Technische Hochschule, Fakultät für Maschinenwesen, Dr.-Ing. Dissertation, 1970. 169 p. 99 refs. In German.

Investigation of rapid changes of state of highly-energetic propellant-oxidizer systems taking into consideration the kinetics of individual chemical reactions with the aim of studying reactions not amenable to equilibrium thermodynamical consideration by non-equilibrium approaches. Particular attention is given to processes of combustion and recombination in ramjets and rocket nozzles. Methods used for the computations involving nonequilibrium conditions are discussed. In a comparison between theoretical results and experimental data it is found that the computational approaches developed provide a useful method for calculating the performance in a rocket propulsion system. G.R.

A71-17107 # **A theoretical and experimental investigation concerning the diffraction of shock waves (Eine theoretische und experimentelle Untersuchung zur Beugung von Stosswellen).** Siegmar Schultz. Rheinisch-Westfälische Technische Hochschule, Fakultät für Maschinenwesen, Dr.-Ing. Dissertation, 1970. 98 p. 25 refs. In German.

Study of the diffraction of shock waves in the region of perfect gas behavior for various angles taking into consideration theoretical and experimental investigations concerning diffractions at corners. A model which provides a correct representation for a number of phenomena occurring during the diffraction of shock waves is discussed. Relations between shock contour and Mach number are explored, and a procedure for estimating the sensitivity of shock fronts to changes in the diffracting angle is developed. The case of a diffraction at a corner with an angle of -165 deg is experimentally investigated. Some interesting relations are obtained in connection with the experimental results by making use of perturbation methods. G.R.

A71-17125 **Fundamentals of aircraft piston engines.** N. E. Borden, Jr. and W. J. Cake (United Aircraft Corp., Pratt and Whitney Aircraft Div., East Hartford, Conn.). New York, Hayden Book Co., Inc., 1971. 198 p. $6.95.

This illustrated guide to piston engine basics is presented to fill the need for a simplified, modern-day text suitable for the beginner who is preparing to operate or maintain any of the various engines now being used in fixed-wing aircraft and helicopters. It is considered that once the reader has mastered the fundamentals, it should be a comparatively easy matter to understand and follow the various aircraft flight and operation manuals, engine maintenance and overhaul manuals, and other publications prepared by aircraft and engine manufacturers or issued as military technical orders. The text begins with a brief history of aircraft piston engine development, then describes the function of various engine parts, and gives detailed definitions of engine terminology. Principal engine systems, such as ignition, lubrication, cooling, induction, carburization, and fuel injection, are discussed. Special attention is given to the new opposed engines that power private and business aircraft. The explanations are reinforced by complete engine illustrations, and a series of review questions follows each chapter. F.R.L.

A71-17150 **Calculation of the flow field downstream of the fan nozzle of a turbofan aero engine.** P. G. Street (National Gas Turbine Establishment, Farnborough, Hants., England). *Aeronautical Journal*, vol. 74, Dec. 1970, p. 983-987. 7 refs.

Analysis of the flow field downstream of the fan nozzle of a turbofan engine making use of an approach developed by Kantrowitz (1960) from Guderly's method. The boundary-layer theory and the method of characteristics have been successfully combined in a step by step technique for predicting supersonic flow fields over bodies of revolution. The method is being applied to the flow of the fan exhaust of high by-pass engines over the gas generator cowling. G.R.

A71-17152 **Loughborough University of Technology, Symposium on Aerodynamic Noise, Loughborough, Leics., England, September 14-17, 1970, Preprints.** Loughborough, England, Loughborough University of Technology, 1970. 252 p.

Contents:

A71-17154 # **A fluid mechanics view of aerodynamic sound theory.** W. C. Meecham (California, University, Los Angeles, Calif.). In: Loughborough University of Technology, Symposium on Aerodynamic Noise, Loughborough, Leics., England, September 14-17, 1970, Preprints. Loughborough, England, Loughborough University of Technology, 1970, p. B.2.1-B.2.15. 10 refs.

A systematic theory for the generation of aerodynamic sound, stated in terms of convected simple sources and dipoles is presented. The sources are found to depend upon convective derivatives of the hydrodynamic pressure within the turbulence source region. The theory shows explicitly the refractive effects of shear flow within the source region, as well as of temperature changes (if any) within the source region. The oscillating cylinder problem is then discussed and the results are compared for the present theory, for a somewhat simplified version of the Lighthill-Curle theory, and for Lauvstand's theory for the problem (using matched asymptotic expansions). It is found that the present theory correctly predicts the sound field intensity for this problem as proposed by Lauvstad. (Author)

A71-17155 # **A survey of low velocity and coaxial jet noise with application to jet prediction.** K. W. Bushell (Rolls-Royce, Ltd., Hucknall, Notts., England). In: Loughborough University of Technology, Symposium on Aerodynamic Noise, Loughborough, Leics., England, September 14-17, 1970, Preprints. Loughborough, England, Loughborough University of Technology, 1970, p. B.3.1-B.3.23. 17 refs. Research supported by the Ministry of Technology.

A review of recent published data on low velocity 'jet' noise is given together with previously unpublished results taken from the Rolls-Royce Noise Research Programme on model rings and full scale engines. 'Jet' noise correlations are given which show that at low jet velocities, the low frequency exhaust noise from the fan stream of a turbofan engine is considerably lower than that from the (hot) centre stream. From this result, a new prediction procedure for coaxial jet noise of turbofan engines is then developed. Comparisons are given which show that this method gives good correlation with measured results from a number of full scale turbofan engines. The importance of accurate estimation of the 'ground reflection effect' is clearly demonstrated. A critical review of published jet noise data from model coaxial jets is given and the need for further extensive testing emphasized. (Author)

A71-17156 # **A comparison between weak-shock theory and Burgers' equation in nonlinear acoustics.** David T. Blackstock. In: Loughborough University of Technology, Symposium on Aerodynamic Noise, Loughborough, Leics., England, September 14-17, 1970, Preprints. Loughborough, England, Loughborough University of Technology, 1970, p. C.1.1-C.1.22. 41 refs.

Comparative evaluation of weak-shock theory and Burgers' equation for solving propagation problems in nonlinear acoustics. The early historical developments in the theory of finite-amplitude sound are reviewed. It is pointed out that, in the case of plane waves, the advantage of using Burgers' equation is that, since an exact solution is known, all details of the wave motion are in principle available. In practice, however, the exact solution generally proves to be so complicated that these details are hard to extract. The weak-shock method, on the other hand, yields much important information about the wave motion comparatively quickly and easily. Its defect is that it leads to erroneous results in some cases, notably at great distances from the source. It is possible to generalize both methods so as to include nonplanar one-dimensional waves. In the case of the weak-shock method, the required transformation leads to equations that have exactly the same form as those for plane waves. Unfortunately, the same is not true of the method based on Burgers' equation; a form of Burgers' equation evolves that has no known solution. Sawtooth waves and N waves, including the cylindrical case (sonic boom), are considered in order to illustrate the various points. M.M.

A71-17157 # **Propagation of non-linear signals in air.** D. F. Pernet (Ministry of Technology, National Physical Laboratory, Teddington, Middx., England). In: Loughborough University of Technology, Symposium on Aerodynamic Noise, Loughborough, Leics., England, September 14-17, 1970, Preprints. Loughborough, England, Loughborough University of Technology, 1970, p. C.2.1-C.2.19. 16 refs.

The results of a theoretical and experimental investigation into the nonlinear, planar propagation of sinusoidal and band-limited noise signals in air are presented. Signals with a fundamental frequency between 500 Hz and 3000 Hz and with sound pressure levels up to 165 dB were used in the experimental investigation and were transmitted over a distance of 60 m in a tube. The extension to spherical waves and the possible role played by nonlinearity in the propagation of aircraft noise are discussed. (Author)

A71-17158 * # **A review of rotating blade noise technology.** Harvey H. Hubbard, Donald L. Lansing, and Harry L. Runyan (NASA, Langley Research Center, Dynamic Loads Div., Hampton, Va.). In: Loughborough University of Technology, Symposium on Aerodynamic Noise, Loughborough, Leics., England, September 14-17, 1970, Preprints. Loughborough, England, Loughborough University of Technology, 1970, p. D.1.1-D.1.43. 28 refs.

Rotating blade noise is a topic of wide concern because it is the source of a variety of noise problems. These concerns range from safety, on the one hand, to community acceptability on the other. The purpose of this paper is to provide a general technical background for the problems of noise due to rotating blades. The topics to be covered are: the vehicles and components for which these problems are pertinent, the nature of the noise produced, the sources of the noise, concepts of noise generation, identification of the significant parameters in noise generation and reduction, and the methods of noise prediction. Both free rotors and ducted rotors are considered. (Author)

A71-17159 # **Rotor noise radiation in nonuniform flow.** M. V. Lowson (Loughborough University of Technology, Loughborough, Leics., England). In: Loughborough University of Technology, Symposium on Aerodynamic Noise, Loughborough, Leics., England, September 14-17, 1970, Preprints.
Loughborough, England, Loughborough University of Technology, 1970, p. D.2.1-D.2.20. 16 refs.

Discussion of theoretical work describing the radiation of sound by a rotor due to interaction with various types of nonuniform flow. An expression is given for the noise radiation by a blade interacting with both steady and unsteady nonuniformities. Spectra and directionality patterns for characteristic types of nonuniformity are shown. The effect of multiple blades is considered and is found to give rise to a weighting function which multiplies the spectral output of the single blade. This weighting function includes delta functions at the blade passage frequencies and also at the engine shaft orders for a nonuniform rotor. The function also includes a background level due to random blade-to-blade variations which reaches a maximum at the discrete frequencies if blade-to-blade variations are correlated. The effect of spanwise variations is considered, and the duct is shown to preferentially reduce sideline noise. The results suggest that in many cases nonuniform flow can be the most significant cause of noise radiation from a rotor and that, to reduce noise at source, strenuous efforts to achieve greater uniformity are justified. M.M.

A71-17160 # **Tone radiation from an isolated subsonic rotor.** C. L. Morfey (Southampton, University, Southampton, England). In: Loughborough University of Technology, Symposium on Aerodynamic Noise, Loughborough, Leics., England, September 14-17, 1970, Preprints. Loughborough, England, Loughborough University of Technology, 1970, p. D.3.1-D.3.7.

At subsonic tip speeds, the far-field sound radiated from steady blade loading is critically dependent on the spatial uniformity of the flow entering the rotor. The radiated power in turbulent flow may be several orders of magnitude greater than in a perfectly smooth flow, where considerable near-field cancellation occurs (Ffowcs Williams and Hawkings, 1969). A simplified theoretical model is set up which allows this effect to be evaluated quantitatively, and numerical results are presented. (Author)

A71-17161 # **Subsonic fan noise.** B. Barry and C. J. Moore (Rolls-Royce, Ltd., Derby, England). In: Loughborough University of Technology, Symposium on Aerodynamic Noise, Loughborough, Leics., England, September 14-17, 1970, Preprints.
Loughborough, England, Loughborough University of Technology, 1970, p. D.4.1-D.4.23. 6 refs.

Determination of the rotor noise of subsonic fans which results from aerodynamic intake flow distortions, using helicopter rotor noise theories. Extensions to these theories are presented which allow for both stationary phase-related distortions and distortions which vary randomly with time and may therefore be considered to rotate with random speeds. It is shown that the aerodynamic interaction of intake distortions with the blades result in both rotor order tones and broad band noise. The dominance of the one over the other depends on the space time correlation of the distortions and the magnitude of typical fan length and time scales. Modulation effects are considered. The use of induct measurements is discussed, and results are presented to show the relative importance of steady and unsteady distortions in a simple fan rig. The amplitudes of the resultant blade force distortions were determined from on-axis acoustic data and used to predict the full forward radiation field. Z.W.

A71-17162 # **Sound radiation from a point force in circular motion.** H. K. Tanna and C. L. Morfey (Southampton, University, Southampton, England). In: Loughborough University of Technology, Symposium on Aerodynamic Noise, Loughborough, Leics., England, September 14-17, 1970, Preprints.
Loughborough, England, Loughborough University of Technology, 1970, p. E.5.1-E.5.50. 14 refs.

Theoretical study of sound radiation from a point force in accelerative motion, where the acceleration arises from steady rotation in a circle. The study is prompted by the question of how significant such effects are in fan or helicopter rotor noise at subsonic tip speeds. Exact expressions have been obtained in closed form for the overall far-field radiation (directivity and total power) from a point force moving uniformly in a circle. A series approximation has been developed to show how the spectrum of far-field radiation is influenced by rotation. M.V.E.

A71-17163 • # **Sound radiation from random quadrupole source distributions in axial flow fans.** N. Chandrashekhara. In: Loughborough University of Technology, Symposium on Aerodynamic Noise, Loughborough, Leics., England, September 14-17, 1970, Preprints. Loughborough, England, Loughborough University of Technology, 1970, p. E.6.1-E.6.11, E.6.13-E.6.17. 5 refs. Research supported by the Ministry of Technology and NASA.

The effect of the interaction of inlet turbulence with the rotor potential flow as a source of noise in axial flow fans is described here by detailed experimental results on an 8 and a 10 bladed rotor. The noise measurements indicate the band spreading of discrete tones at blade passing frequency and its harmonics. The description of inlet turbulence is given by spatial cross-correlation measurements in the radial and circumferential directions. An expression for sound power radiated in the upstream radiation field is developed and evaluated by using the near field flow measurements. This is compared with the direct measurements in the upstream radiation field. (Author)

A71-17166 # **Interferential variations in gasdynamics (Ob interferentsionnykh izmeneniiakh v gazovoi dinamike).** E. P. Kazandzhan and V. S. Sukhorukikh. *Akademiia Nauk SSSR, Doklady,* vol. 194, Oct. 11, 1970, p. 1045-1048. In Russian.

Analysis of interferential patterns dealt with when holographic interferometry is applied in gasdynamics. It is noted that achromatic observations in addition to monochromatic observations are frequently needed for obtaining complete interferential band patterns by conventional techniques. A theoretical basis is set forth for measurements of interferential patterns with adequate results in monochromatic light alone. Functions are defined and expressions are derived on which this technique is based. A comparison suggests good agreement between the results of this method and conventional monochromatic-achromatic observations. V.Z.

A71-17194 # **Measurement of geomagnetic components from moving platforms (Izmerenie geomagnitnykh komponent s dvizhushchikhsia platform).** A. Ia. Rotshtein and I. G. Zhurii (Akademiia Nauk SSSR, Institut Zemnogo Magnetizma, Ionosfery i Rasprostraneniia Radiovoln, Leningrad, USSR). *Geomagnetizm i Aeronomiia,* vol. 10, no. 5, 1970, p. 883-887. 10 refs. In Russian.

Discussion of direct and indirect methods of measuring geomagnetic components from ships or aircraft in a system of coordinates which is fixed in space. Direct and indirect methods of stabilizing the system of coordinates are also studied. It is shown that direct stabilization methods have the advantage of permitting direct measurement of any geomagnetic component in such a way that the results can be averaged without errors over an arbitrary period of time. V.P.

A71-17195 # **Aircraft refractometer (Samoletnyi refraktometr).** V. N. Bormotov, I. D. Gontar', and V. F. Shul'ga (Akademiia Nauk Ukrainskoi SSR, Institut Radiofiziki i Elektroniki Kharkov, Ukrainian SSR). *Geomagnetizm i Aeronomiia,* vol. 10, no 5, 1970, p. 888-892. In Russian.

Discussion of the design and principles of operation of ar onboard refractometer operating at the 3.2 cm wavelength. Particula

attention is given to the design of the resonator, on which the effectiveness of the instrument depends, and to a circuit by means of which the frequency of two klystron oscillators is phase locked to the resonator resonant frequencies. The block diagram for measuring the frequency difference of the two klystrons is examined. Mounted on an IL-18 aircraft, the device proved to be highly effective under adverse flight conditions at a height of 11 km. V.P.

A71-17219 The initial structure of wing-body interaction in supersonic flow. R. T. Waechter (University College, London, England). *Institute of Mathematics and Its Applications, Journal,* vol. 6, Dec. 1970, p. 310-318. 5 refs. Research supported by the Ministry of Technology.

A rigorous asymptotic expansion describing the initial structure of wing-body interaction in steady inviscid supersonic flow is obtained from the exact solution of a canonical problem. A further term is found for the velocity potential on the root chord, and it is shown how two different asymptotic expansions due to Stewartson may be derived from an asymptotic expansion which is uniformly valid right up to the root chord. (Author)

A71-17228 # Making general aviation safer and more effective through universal electronic design. George Litchford. *Astronautics and Aeronautics,* vol. 9, Jan. 1971, p. 36-41.

Discussion of approaches based on electronic technology for making general aviation safer and more effective for its users and its neighbors in the air and on the ground. The development of a wide-area lf-vlf navigation system primarily for general aviation but serving the airlines also is discussed. The advantages of a beacon transponder, which is now included in new FAA requirements, are considered. Economical problems connected with the use of altimeters of good accuracy are examined, and the possibility of solving the separation problem by vertical radar is investigated. Advantages of vlf compared to VORTAC are shown. G.R.

A71-17248 A test to determine the corrosion resistance of adhesive-primer systems. D. R. Croke, W. E. Krupp (Lockheed Materials Research Laboratory, Saugus, Calif.), W. C. Robinson, Jr. (Union Carbide Corp., Electronics Div., Greenville, S.C.), and R. N. McCurdy (Pierce College, Woodland Hills, Calif.). *Materials Research and Standards,* vol. 11, Jan. 1971, p. 19-21, 38.

Development of a simple test that simulates the combination of shear, compression buckling, and clevage stresses at an adhesive/metal interface by means of a fixture that can be suspended in a salt fog chamber. The severe nature of this test makes it possible to extrapolate for 15 years of service life from a 60-day salt fog exposure. The test method described was used for screening candidate adhesive-primer systems submitted for bonding aircraft structures. Z.W.

A71-17319 The use of cathode-ray tubes in professional equipment. A. B. McFarlane (M-O Valve Co., Ltd., London, England). *Radio and Electronic Engineer,* vol. 40, Dec. 1970, p. 289-299. 21 refs.

The vast range of professional equipment which uses a cathode-ray tube as the display device is considered in terms of the following classification: (1) oscillography and precision measurements, (2) visual display computer terminals, (3) avionic displays, (4) radar, (5) medical electronics, and (6) automated and control systems. In each case the general function and performance of relevant equipment is outlined, and the way in which these determine the type of cathode-ray tube used is discussed. Special aspects of tube design are dealt with in more detail, and desired future improvements indicated. (Author)

A71-17331 On constructing efficient evasion strategies for a game with imperfect information. Paul A. Meschler (General Research Corp., Santa Barbara, Calif.). *IEEE Transactions on Automatic Control,* vol. AC-15, Oct. 1970, p. 576-580. 5 refs.

Description of an evasion method for pursuit-evasion games. In structuring tactics for evading a pursuing vehicle P, it is often the case that the evader E does not know the intercept time. E's policy must by necessity be random, the precise definition being dependent on the dynamic description of the vehicles and the geometry of the engagement. A method of designing efficient evasion tactics that apportions available maneuver effort over a time interval so as to make the expected pursuer miss distance independently of intercept time is presented. The evasion maneuvers are also structured so that E reaches the confines of some defended region, his ultimate goal. M.M.

A71-17410 The temporal progress of the combustion of hydrogen in a supersonic flow of air (Der zeitliche Ablauf der Verbrennung von Wasserstoff im Überschall-Luftstrom). Johannes Algermissen and Dieter Nötzold. *Forschung im Ingenieurwesen,* vol. 36, no. 6, 1970, p. 169-184. 41 refs. In German.

Discussion of the reaction mechanisms involved in the combustion of hydrogen and of the combustion reaction taking place in a hypersonic ramjet using hydrogen as fuel. The principles of operation of a hypersonic ramjet are examined, and the mechanisms for possible reactions involving hydrogen are considered giving attention to collisions between atoms, radicals and molecules. Reactions involving nitrogen, which is present in the air, are also examined. A general equation system for describing the processes taking place during the combustion in the ramjet is presented. Values for the constant factors in the reaction rate equations are listed, and a simplified computational model for the hydrogen combustion is discussed. The significance of the results for ramjet operation under various conditions is investigated. G.R.

A71-17415 Corrosion - A study of recent Air Force experience. John S. Leak (USAF, Norton AFB, Calif.). *Materials Protection and Performance,* vol. 10, Jan. 1971, p. 17-20.

Corrosion costs the Air Force considerable sums of money and man-hours in weapon systems and component losses and repair. This paper discusses some of the corrosion problems and contains examples of the ultimate damage corrosion can cause. Stress corrosion problems and corrective measures in aircraft landing gear components are explained in terms of design, quality control, material selection, and manufacturing processes. (Author)

A71-17418 Investigations of slender, conical wing-body combinations in supersonic flow, particularly with respect to volume distribution and camber (Untersuchungen an schlanken, kegligen Rumpf-Flügel-Kombinationen in Überschallströmung, insbesondere hinsichtlich Volumenverteilung und Wölbung). Wolfgang Stahl (Aerodynamische Versuchsanstalt, Göttingen, West Germany). *Zeitschrift für Flugwissenschaften,* vol. 18, Dec. 1970, p. 461-473. 41 refs. In German. Research supported by the Bundesministerium der Verteidigung.

Investigation of slender, conical, plane, and cambered wing-body combinations with different volume distributions in supersonic flow. All combinations examined had the same triangular planform and nearly the same volume. Lift, drag, and pitching moment were determined experimentally; in particular, the nonlinear lift component was studied more closely. The influence of the volume distribution in spanwise direction, as well as the possibility of obtaining a drag reduction by suitable camber near the leading edges for a certain lift coefficient were examined. The test results are compared with the predictions of the corresponding theories. Efforts have been made to obtain a better agreement by an extension of the

theories. The measurements show that the influence of the volume distribution on lift and drag of the wind-body combinations is unimportant. The drag can be reduced by the chosen camber. The extension of the theories is found to improve the agreement with the measured results. O.H.

A71-17420 On an improvement of the bisector rule for shock waves. A. I. van de Vooren and D. Dijkstra (Groningen, Rijksuniversiteit, Groningen, Netherlands). *Zeitschrift für Flugwissenschaften,* vol. 18, Dec. 1970, p. 476-479. 6 refs.

The bisector rule for weak shocks asserts that the shock front bisects the angle between the Mach lines before and behind the shock. The rule is valid for terms of first order of the shock strength. In this paper a new formula is presented which is correct for terms of second order of the shock strength. The result is applied to the determination of the asymptotic behavior of the bow shock attached to an aerofoil in two-dimensional steady supersonic flow. (Author)

A71-17421 A note on sound generation by turbulent circular free jets (Eine Bemerkung zur Schallerzeugung durch turbulente, runde Freistrahlen). Alfons Michalke (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Institut für Turbulenzforschung, Berlin, West Germany). *Zeitschrift für Flugwissenschaften,* vol. 18, Dec. 1970, p. 479, 480. 5 refs. In German.

Theoretical examination of the spectral components of sound generated aerodynamically in circular jet flows. A solution to the inhomogeneous acoustical wave equation by Lighthill is presented which makes it possible to understand the experimentally observed variable behavior of the spectral components of sound at high and low frequencies, even if the expression defining the acoustical source properties of a fluctuating flowfield is not exactly known. O.H.

A71-17422 The legal status of air charter flights (Le statut juridique des affretements aériens dits 'charters'). E. Du Pontavice (Paris, Université, Faculté de Droit et des Sciences Economiques, Sceaux; Nantes, Université, Nantes, France). *Revue Générale de l'Air et de l'Espace,* vol. 33, no. 3, 1970, p. 241-257. 103 refs. In French.

General consideration of various aspects of air charters, with emphasis on the transport of passengers by chartered aircraft. Because of its flexibility and low price, the air charter is well adapted to tourism. There is some evidence that chartered aircraft have a higher accident rate than is the case with regularly scheduled carriers. Charter parties may be entered into by air transport companies, travel agents, affinity groups, or, more rarely, by a single individual. Various facets of public, private, and international law as they affect air charters are explored, and attention is given to the law of civil responsibility. F.R.L.

A71-17423 The nationality of aircraft - Reexamination of a disputable concept (La 'nationalité' des aeronefs - Pour une remise en cause d'une notion discutable). J.-M. Breton (Cameroun, Université Fédérale, Yaoundé, Cameroon). *Revue Générale de l'Air et de l'Espace,* vol. 33, no. 3, 1970, p. 258-273. 45 refs. In French.

Discussion of the legal problems faced by Air Afrique, which arise from the fact that this airline operates in and out of, and overflies, many independent nations. Regional cooperation and aircraft registration are considered with reference to the Chicago Convention of 1944. Theoretical aspects of the problem of aircraft nationality are reviewed, as well as various solutions to the problem and their import. F.R.L.

A71-17424 The revision of the Warsaw Convention and the responsibility of the air carrier (La révision de la Convention de Varsovie et la responsabilité du transporteur aérien). Jean Constantinoff. *Revue Française de Droit Aérien,* vol. 24, Oct.-Dec. 1970, p. 393-408. 64 refs. In French.

Discussion of possible revision of the 1929 Warsaw Convention, which regulates air travel, and of the possibility of the secession of the U.S. from its provisions. The principal question is whether or not the responsibility limits of the air carrier can or can not be exceeded. The problem turns on whether Articles 3 and 25 could be suppressed, since these articles make it possible for American courts to render decisions which are more favorable to accident victims. F.R.L.

A71-17425 Elements of Rumanian air penal law - The air code of 1953 and the penal and penal procedure codes of 1969 (Eléments de droit pénal aérien Roumain - Le code aérien de 1953 et les codes pénal et de procédure pénale de 1969). P. V. Patrascanu (Bucureşti, Universitatea, Bucharest, Rumania) and O. Sachelarie (Institutul de Istorie, Bucharest, Rumania). *Revue Française de Droit Aérien,* vol. 24, Oct.-Dec. 1970, p. 409-428. 41 refs. In French.

Review of Rumanian air law which, as is the case with international air law, is primarily occupied with the organization and control of civil aviation, but also with infractions of law committed during the flight of an aircraft, such as crimes against persons and property, or air piracy. The various statutes discussed are, to some extent, based on French and Italian codes. Infractions and sanctions and the applicability of the penal law, and its competence as regards Rumanian aircraft overflying other countries, are considered. F.R.L.

A71-17433 # Chemical stabilization of engine and jet fuels (Khimicheskaia stabilizatsiia motornykh i reaktivnykh topliv). M. F. Vol'f. Moscow, Izdatel'stvo Khimiia, 1970. 373 p. 620 refs. In Russian.

Problems associated with the chemical stabilization automobile and aircraft ethylated gasolines and jet and diesel fuels during storage, transportation, and utilization are discussed. Domestic and foreign experience in improving fuel stabilization by such additions as antioxidizing and dispersing agents and deactivators of metals is reviewed. Techniques used for introducing chemical additions to the fuels are examined, together with accepted methods of testing and evaluating the stability of gasolines and jet and diesel fuels. The book is intended for scientists and engineers employed in the petroleum industry, and for individuals specializing in storing fuels. V.P.

A71-17573 Metro bucks heavy economic tide. Bob Glaves. *Business and Commercial Aviation,* vol. 28, Jan. 1971, p. 61-65.

Review of the economic problems besetting the Metro commuter airliner. It is considered by the manufacturer that, although corporations have the money to buy aircraft, not many wish to invest at the present time. The current production rate is three Merlins per month and sales are to be handled directly from the factory. A major problem is the 12,500-lb zero fuel weight. F.R.L.

A71-17581 • # Measurements and analysis of lightning-induced voltages in aircraft electrical circuits. Paul T. Hacker (NASA, Lewis Research Center, Aerospace Safety Research and Data Institute, Cleveland, Ohio) and J. A. Plumer (GE High Voltage Laboratory, Pittsfield, Mass.). *Society of Automotive Engineers and U.S. Air Force Avionics Laboratory, Lightning and Static Electricity Conference, San Diego, Calif., Dec. 9-11, 1970, Paper.* 28 p. 13 refs.

A series of measurements were made of voltages induced in electrical circuits within a metallic aircraft wing by full-scale simulated lightning currents flowing through its skin and structure. The measured data were mathematically analyzed to enable determination of voltages across load impedances to which the circuits might be connected elsewhere in the aircraft. Relationships between induced voltages and lightning current and wing structural and circuit parameters were determined. Induced voltages of magnitudes likely to cause damage or interference with avionics were measured. (Author)

A71-17586 The democratization of air transport (La démocratisation du transport aérien). Robert Vergnaud (Air Inter/ Lignes Aériennes Intérieures, Paris, France). *Secrétariat Général à l'Aviation Civile, Revue,* Oct. 15, 1970, p. 70-79. In French.

Consideration of the possibilities for popularization of air travel, which at present is not practical for most citizens. Simpler access to this mode of travel can be achieved by transport in groups, and by fare adjustments for certain categories of travelers - e.g., social organizations and for young or elderly persons. At present, businessmen, professional people, and students account for more than half of the passengers. Government employees, military personnel, and employed persons, mostly traveling with expenses paid, make up the balance. F.R.L.

A71-17587 French statistical system for air transport (Système statistique Français du transport aérien). Christian Piro (Institut National de la Statistique, France). *Secrétariat Général à l'Aviation Civile, Revue,* Oct. 15, 1970, p. 83-93. In French.

Description of the statistical system used by the French Civil Aviation Secretariat (SGCA) to obtain knowledge of air transport operations. The subject is considered from the airport point of view (aircraft movements, local passenger traffic, freight and mail, through passengers, and transferring passengers). A traffic unit is established which corresponds to 1000 passengers or 100 tons of cargo or mail. Similarly, attention is given to the problem from the point of view of the carrier. It is considered that improvement of the statistical system should result from the convergence of two elements: a better knowledge of user requirements, and improvement in procedures. F.R.L.

A71-17588 The reception of large capacity aircraft (L'accueil des avions de grande capacité). Germaine Ladet (Secrétariat Général à l'Aviation Civile, Inspection Générale de l'Aviation Civile, Paris, France). *Secrétariat Général à l'Aviation Civile, Revue,* Oct. 15, 1970, p. 94-108. In French.

Consideration of the problems involved in receiving and servicing very large aircraft, with evaluation of their relative importance. Attention is first given to the studies undertaken to solve them on the interministerial level, followed by more detailed examination of arrangements either already made or proposed to facilitate traffic. Comment is made on certain obstacles encountered. F.R.L.

A71-17589 The adaptation of airports to large capacity aircraft (L'adaptation des aéroports aux avions à grande capacité). Jean-Louis Durand (Secrétariat Général à l'Aviation Civile, Service Technique des Bases Aériennes, Paris, France). *Secrétariat Général à l'Aviation Civile, Revue,* Oct. 15, 1970, p. 108-118. In French.

Discussion of those aspects concerning airports, their terminal installations and their infrastructure, runways, roads, and traffic areas which have been affected by the advent of large capacity aircraft. Attention is given to problems of maneuvering and parking these aircraft, and the effects of tail pipe blast. This can be damaging to runways, taxi tracks, and to surrounding areas, especially during takeoff or when taxiing at high speed. Passenger and baggage handling is discussed. F.R.L.

A71-17590 The Lyons-Satolas International Airport project (Le projet d'Aéroport International de Lyon-Satolas). Jean-Paul Paufique. *Secrétariat Général à l'Aviation Civile, Revue,* Oct. 15, 1970, p. 119-133. In French.

Description of the principal arrangements of the new Lyons-Satolas International Airport project, with outline of the current state of the studies. The present airport, Lyons-Bron, is considered to have only limited possibilities, and studies indicate that the Lyons metropolitan area will generate more than four times its present traffic by 1980. Considerations of urban development and regional management were taken into account. Details of the layout of the new airport with reference to its runways, terminal areas, and facilities are given. The noise problem and its control are discussed. F.R.L.

A71-17619 Basic design considerations and theoretical analysis of double-reverberant chamber duct lining test facilities. T. H. Melling and P. E. Doak (Southampton, University, Southampton, England). *Journal of Sound and Vibration,* vol. 14, Jan. 8, 1971, p. 23-35. 6 refs.

Basic design criteria for establishing the geometry of a duct liner test facility are evolved. A theoretical model of the facility is established, yielding the acoustic behavior of the test section alone. The measurements necessary for the interpretation of the test section performance are discussed. Finally, models of the attenuation in the test section are presented for correlation with theoretical models of acoustically treated ducts. Two principal features of the analysis are that it includes the following effects: (1) that of flow on the acoustic fields as well as on the liner absorption; (2) that of possible variations in the impedance of the terminating chamber - e.g., it could be anechoic rather than reverberant. (Author)

A71-17620 Sound transmission and generation in ducts with flow. C. L. Morfey (Southampton, University, Southampton, England). *Journal of Sound and Vibration,* vol. 14, Jan. 8, 1971, p. 37-55. 22 refs.

Sound generation in hard-walled ducts with flow is treated theoretically. Axial standing waves are allowed for in the theoretical model, by applying an impedance boundary condition at the ends of the duct. The results show the effects of axial and swirling flow on the radiated sound power, for different types of source contained in the duct. Suggestions are also put forward for analyzing the generation of sound by sources at a mean-flow discontinuity. (Author)

A71-17621 The effect of lateral vibrations on vortex shedding from blunt-based aerofoils. C. J. Wood (Oxford University, Oxford, England). *Journal of Sound and Vibration,* vol. 14, Jan. 8, 1971, p. 91-102. 17 refs. Science Research Council Grant No. B/SR/3271.

The effect of two kinds of lateral oscillation, mechanical and acoustic, are compared in regard to their effects upon the vortex-shedding mechanism at the blunt trailing edge of an aerofoil. Relying upon certain points of similarity between the two flows, the results of flow visualization experiments in heaving motion are used to explain both the way in which vortex shedding can excite acoustic resonance and also the effect of a base cavity in damping resonant vibration. (Author)

A71-17624 Adhesive bonding of high modulus composite aircraft structures. Samuel J. Dastin and George Lubin (Grumman Aerospace Corp., Bethpage, N.Y.). *Society of Automotive Engineers, Automotive Engineering Congress, Detroit, Mich., Jan. 11-15, 1971, Paper 710110.* 8 p. Members, $1.00; nonmembers, $1.50.

Description of the production of a horizontal stabilizer of an aircraft involving structural adhesive bonding between boron-epoxy composite, titanium, steel, aluminum honeycomb, and fiberglass epoxy. The adhesive tests were conducted using short-span beam shear and flatwise tensile tests. The adhesive design allowables were developed using lap shear tests at various overlap lengths. The 'stepped' technique used in the fabrication of the primary skin joint is described. Special attention is given to the autoclaving molding of the boron-epoxy composite, methodology of adhesive co-cures, and the mylar isolation skin-to-core bonding procedure. The quality control of manufactured parts is briefly described. Z.W.

A71-17644 **The age of the supersonic jet transport - Its environmental and legal impact.** John R. Montgomery. *Journal of Air Law and Commerce,* vol. 36, Autumn 1970, p. 577-614. 176 refs.

Discussion of the technical aspects of the supersonic jet transport and the ability of present law to cope with the problems which inevitably will occur if land overflights are allowed. Achievements and drawbacks of SST technology are considered. The ground noise problem and approaches for overcoming it are discussed. The sonic boom problem is examined, and the effect of aircraft design and atmospheric conditions on sonic boom intensity is explored. The focusing phenomenon, the effects of sonic boom on persons and property, and the consequences of worldwide SST operations are discussed. The state of American law and the status of international law with respect to the legal problems posed by the operation of the SST are described. G.R.

A71-17661 # **The effect of homogeneous additives on the ignitability of hydrocarbon fuels.** V. J. Siminski and F. J. Wright (ESSO Government Research Laboratory, Linden, N.J.). *Combustion Institute, Fall Meeting, California Institute of Technology, Pasadena, Calif., Oct. 26, 27, 1970, Paper WSS/CI 70-19.* 35 p. 13 refs. Contract No. AF 33(615)-69-C-1289.

Investigation of the molecular structural characteristics that promote ready ignition of hydrocarbon fuels and of ignition promoters for such fuels. The ranking of the fuels and of the homogeneous additives for their ease of ignition was carried out in a stirred combustor in an attempt to obtain a comparison based on delays arising from the chemical properties of the fuel rather than from physical or chemical diffusion factors. The data obtained in the stirred reactor show that of all the stable hydrocarbon fuels tested, the long chain n-paraffins exhibit the shortest ignition lags. The homogeneous additives studied consisted of nitrate and nitrite esters, peroxides, epoxides, and polyethers. Some of these additives present in 5 volume percent reduce ignition delays by as much as 90%. M.V.E.

A71-17678 **The magnitude and economic impact of general aviation 1968-1980.** R. Dixon. Research supported by the Avco Corp., the Beech Aircraft Corp., the Cessna Aircraft Co., the Continental Motors Corp., the Garrett Corp., the General Electric Co., the Grumman Aerospace Corp., the Lear Jet Industries, the Lockheed-Georgia Co., the North American Rockwell Corp., the Piper Aircraft Corp., and the United Aircraft Corp. Manhasset, N.Y., Aero House, 1970. 160 p. $15.

This book seeks to assist industry and government in the achievement of the goal of a dynamic and integrated transportation structure, in which the role to be played by General Aviation will be clearly recognized and planned for. The publication integrates in a single volume the findings of 1968 and 1969 reports, covering the development of General Aviation between 1968 and 1980. The magnitude of future development of General Aviation is determined taking into consideration the actual number of active aircraft, the number of flying hours and movements, and the number of airmen and user profiles. General Aviation's contribution to the national economy is determined by evaluating such factors as the value of production and sales of aircraft and avionics, the used aircraft market, user costs, investment spending by manufacturers, dealers and operators, and government outlays. G.R.

A71-17690 **A gas turbine engine health indicator for helicopter operators.** F. J. McCrory, Jr. (U.S. Army, Aviation Test Board, Fort Rucker, Ala.). *American Helicopter Society, Journal,* vol. 16, Jan. 1971, p. 11-15.

The need for a simple, reliable and low cost system for determining the health of gas turbine engines installed in helicopters is presented. The concept of engine health is differentiated from the more common considerations of engine abuse and wearout. The key engine health parameters are discussed. Inherent problems in monitoring these factors in an operational situation are presented and free air temperature corrections essential for their evaluation are outlined. Disadvantages are cited for a go-no-go electromechanical engine health system and an outside-the-cockpit data card system. An Engine Health Indication Test (HIT) system is proposed which overcomes the operational problems and avoids the disadvantages of the other systems. The proposed system consists of an instrument panel health placard for correcting gas temperature and gas producer turbine speed. A log, maintaining a historical record of changes in gas temperature, would be placed in the flight log book and would be used to indicate trends toward higher gas temperatures. An example is presented of the Engine Health Indication Test system, developed for the T53-L-13 series engines in the UH-1H/M and AH-1G helicopters. Use of this system and its advantages are discussed. (Author)

A71-17691 **Rapid estimation of the effects of material properties on blade natural frequencies.** Nicholas Giansante (Kaman Aerospace Corp., Bloomfield, Conn.). *American Helicopter Society, Journal,* vol. 16, Jan. 1971, p. 26-35. Contract No. N 00019-69-C-0088.

A review of existing theory revealed the emphasis to date to be on the application of simplified procedures for rapid estimation of flapwise frequencies of rotating beams with a deficiency of information regarding chordwise and torsional frequencies of free vibration. The present study was initiated to extend existing theory to include chordwise and torsional frequencies of rotating beams as a function of the nonrotating beam frequencies. Further, the effect of stiffness/weight ratio on the flapwise, chordwise, and torsional natural frequencies of rotating beams was introduced. Simplified procedures were developed for rapid estimation of the effects of material properties on the uncoupled flapwise, chordwise, and torsional natural frequencies of rotating beams. (Author)

A71-17692 # **Aerodynamic decelerators - An engineering review.** William B. Pepper and Randall C. Maydew (Sandia Laboratories, Albuquerque, N. Mex.). *Journal of Aircraft,* vol. 8, Jan. 1971, p. 3-19. 215 refs. AEC-supported research.

Survey of the present state of aerodynamic decelerator technology available to the design engineer, with emphasis on the development work of heavy duty ribbon parachutes at Sandia Laboratory. Flexible wings, sometimes called lifting aerodynamic decelerators, are briefly treated. Flexible wings add the possibility of maneuverability and controllability to the otherwise uncontrolled ballistic path of a descending payload system. Numerous references of applicable, significant and timely work are provided to aid the reader in obtaining more detailed information on the various categories of aerodynamic decelerators. The ribbon parachute is a versatile, reliable, and efficient decelerator; a 20-ft-diam parachute has been deployed at a dynamic pressure of 5700 lb/ft at a Mach number of 2.43. A 76-ft-diam ribbon parachute was used to recover a 45,000-lb test vehicle. The guide surface parachute is extremely reliable and useful as a pilot or first-stage parachute and is very stable as a drogue device. Special composite construction methods of a hyperflo parachute are available, permitting the use of this parachute as an economical decelerator at Mach numbers of 4 and greater where aerodynamic heating creates a severe thermal environment. M.M.

A71-17693 # **Perspective of SST aircraft noise problem. I - Acoustic design considerations.** G. S. Schairer, J. V. O'Keefe, and P. E. Johnson (Boeing Co., Seattle, Wash.). *(American Institute of Aeronautics and Astronautics, Annual Meeting and Technical Display, 5th, Philadelphia, Pa., Oct. 21-24, 1968, Paper 68-1023.) Journal of Aircraft,* vol. 8, Jan. 1971, p. 19-25.

Discussion of the SST noise-suppressor research program of the Boeing Company. Recent investigations are identifying key variables and the influence of these variables in reducing the jet exhaust noise of the SST turbojet engines. Based on the systematic model

suppressor tests and parametric studies of the test results, acoustic design charts have been generated and suppressed jet noise spectra extrapolated to full scale to predict SST engine noise characteristics. The noise research work which has already been accomplished is outlined. Some indication is given of the direction in which work to achieve SST engine noise control is likely to proceed in future. P.v.T.

A71-17694 * # **Status of the nuclear powered airplane.** Frank E. Rom (NASA, Lewis Research Center, Cleveland, Ohio). *Journal of Aircraft,* vol. 8, Jan. 1971, p. 26-33. 6 refs.

NASA has been carrying out a low-level effort to determine and solve the problems facing practical, safe and economical nuclear aircraft. The key problem is safety. The prevention of fission product release after a major accident on land is difficult. Studies indicate in principle that fission products can be contained; however, much work needs to be done to demonstrate the proposed techniques. Over-water flight minimizes the safety problem. This suggests the possibility of restricting early nuclear aircraft for over-water flights to gain experience and confidence. The use of thermal reactors appears to simplify the problem of containment because they make possible the avoidance of nuclear excursions in accidents by minimizing the fuel inventory. Low fuel inventory and the desirability of long reactor life requires reactor fuel with very high burnup capability. A fuel concept exists that has promise for meeting this requirement. Nuclear aircraft must weigh more than one million pounds in order that payloads of 15% of the gross weight or greater can be carried. (Author)

A71-17695 # **Evaluation of heat transfer for film-cooled turbine components.** Darryl E. Metzger (Arizona State University, Tempe, Ariz.) and Darrell D. Fletcher (AiResearch Manufacturing Co., Phoenix, Ariz.). *(American Institute of Aeronautics and Astronautics, Propulsion Joint Specialist Conference, 5th, U.S. Air Force Academy, Colorado Springs, Colo., June 9-13, 1969, Paper 69-523.) Journal of Aircraft,* vol. 8, Jan. 1971, p. 33-38. 12 refs.

Description of the results of an extensive series of tests with film injection through flush two-dimensional slots and through single spanwise lines of flush circular holes. Injection angles of 20 and 60° are covered for both injection types over a range of injection rates and downstream distances of interest in turbine cooling applications. In all cases the cooling protection provided by injection through holes is much less than that available with spanwise continuous slot injection. It is noted that the results should provide the designer with a measure of the coolant penalty accrued when structural or other constraints preclude continuous injection slots. M.M.

A71-17696 # **Inlet vortex.** J. L. Colehour and B. W. Farquhar (Boeing Co., Seattle, Wash.). *Journal of Aircraft,* vol. 8, Jan. 1971, p. 39-43. 10 refs.

A sink type flow located near a solid boundary will form a vortex if the circulation in the fluid near the sink is not zero. One end of the vortex will attach to the solid boundary at the stagnation point; the other end passes through the sink attaching to a surface beyond the sink or extending to infinity. This type of flowfield, called an inlet vortex, commonly appears at the engine inlet of a gas turbine propelled aircraft. Identical flows have also been observed at the inlets of open-circuit wind tunnels. The formation of a vortex at the inlet of a gas turbine engine is a nuisance, because of the tendency of the vortex to lift objects from the surface where the objects can be drawn into the inlet and cause severe damage to the compressor blades. The vortex also causes a transient distortion in the flowfield, which can be a hindrance to wind-tunnel studies. This paper describes work conducted at The Boeing Company to study the conditions necessary for existence of the inlet vortex and develop techniques to prevent the formation of the vortex. (Author)

A71-17697 * # **A simplified Kalman estimator for an aircraft landing display.** Robert B. Merrick (NASA, Ames Research Center, Theoretical Guidance and Control Branch, Moffett Field, Calif.). *(American Institute of Aeronautics and Astronautics, Aerospace Computer Systems Conference, Los Angeles, Calif., Sept. 8-10, 1969, Paper 69-944.) Journal of Aircraft,* vol. 8, Jan. 1971, p. 44-49. 5 refs.

Description of the application of Kalman filter simulation for estimating the position and velocity of an aircraft from data given by an airborne digital computer in a zero-zero landing system. The on-board estimator must operate within very limited allowances of computation time (70 milliseconds) and computer storage (600 words). The pertinent observation equations are linearized around the current estimated trajectory. The first mechanization of the Kalman filter approach drastically exceeded the on-board computer constraints. Several substantial simplifications were made to meet these constraints, and the results show that equivalent performance is obtainable with a much simpler system. Z.W.

A71-17698 # **Computer-aided wiring and cabling design as applied to aircraft avionics systems.** W. J. Balchunas (IBM Electronics Systems Center, Owego, N.Y.). *(American Institute of Aeronautics and Astronautics, Aerospace Computer Systems Conference, Los Angeles, Calif., Sept. 8-10, 1969, Paper 69-976.) Journal of Aircraft,* vol. 8, Jan. 1971, p. 50-55.

Discussion of an automated system for producing simplified formats listing wiring data used in cabling a portion of the avionics systems of a light attack aircraft. It is pointed out that such wiring data can greatly facilitate fabrication of harnesses and cables. In essence, the data are compiled from schematics or functional drawings and punched on IBM cards. These cards are then read by a computer, and the data are transferred to magnetic tape which is processed using a 7094 or 360 IBM computer to produce various formats recorded on magnetic tape. G.R.

A71-17699 # **Control surface pumping - A pilot's technique for controlling the flight path precisely.** William Bihrle, Jr. (Grumman Aerospace Corp., Bethpage, N.Y.). *(American Institute of Aeronautics and Astronautics, Atmospheric Flight Mechanics Conference, Tullahoma, Tenn., May 13-15, 1970, Paper 70-567.) Journal of Aircraft,* vol. 8, Jan. 1971, p. 56-58.

The longitudinal control is rapidly pumped by many pilots during precision control tasks. This control pumping phenomenon is analyzed and a method presented for predicting the frequency and amplitude of the control pumping motion to be encountered with a given aircraft design. It is also surmised that control pumping is a control technique through which the pilot can increase the gain in his lead (angular acceleration) network without driving the man-machine control loop unstable and in this manner can perform fine vernier-type of control of the flight path. It is concluded that control pumping, therefore, should not be prevented or discouraged by limiting control surface rates or high stick forces. (Author)

A71-17700 # **A new economic flexible nozzle for supersonic wind tunnels.** Siegfried F. Erdmann (Delft, Technische Hogeschool, Delft, Netherlands). *Journal of Aircraft,* vol. 8, Jan. 1971, p. 58-60.

Discussion of the main design aspects of a flexible nozzle for supersonic wind tunnels. The discussion centers around the SST (supersonic wind tunnel) and the CSST (research tunnel). The intervals between design Mach numbers are 0.1 smaller than Delta M smaller than 0.4, and good flow quality is obtained at intermediate Mach numbers. M.M.

A71-17743 # **Carbon fibres as structural materials.** Hermann Frick. *Dornier-Post* (English Edition), no. 4, 1970, p. 14-16.

The availability of materials with improved efficiency has always exerted an important influence on technological progress. This is most vividly reflected in the various endeavours of the aerospace industry to reduce structural weights. Since the structural weight totals 35% of the take-off weight - even for conventional passenger

aircraft - the feasibility of a project, or at least its efficiency, depends to a high degree on this factor. If we take account of the present status of design and calculation techniques, the most distinct progress in the foreseeable future can be expected in the field of new materials. (Author)

A71-17745 # **Icing - No problem for the Do 132.** Christoph Fischer. *Dornier-Post* (English Edition), no. 4, 1970, p. 26-29.

It is common knowledge that, even today, flying is still dependent on the whims of the weather. Large amounts of money have been directed into the development of equipment with a view of securing greater independence of the weather. The cost of such equipment is high, both as far as the equipment in the aircraft itself is concerned and the ground facilities appertaining to it. (Author)

A71-17922 # **Flight in poor visibility.** J. D. Proctor. *Institute of Navigation, Journal,* vol. 24, Jan. 1971, p. 86-90.

Discussion of the difficulties experienced by aircrews in maintaining visual meteorological conditions in relation to visibility. Similar difficulties which also arise from the requirement to keep certain distances horizontally and vertically from clouds are also discussed, together with the control of bad weather landing approaches. The following improvements to the safety and control of bad weather approaches are suggested: (1) provision of instrumental and visual aids; (2) research to find a better criterion of whether a safe approach and landing can be made to 'visual airports'; (3) closer specification of approach paths, overshoot paths and 'tunnels,' and holding patterns and sector safe altitudes, at visual airports; and (4) specification of approach paths to as many runways as possible at other airports, and prohibition of nonspecific approaches. M.M.

A71-17923 # **Meteorology and all-weather operations.** E. Chambers (British Overseas Airways Corp., London Airport, Hounslow, Middx., England). *Institute of Navigation, Journal,* vol. 24, Jan. 1971, p. 91-104.

Discussion of the certainty that the importance of all-weather takeoff and landing for the safe and economic operation of the larger and faster types of air transport that are being introduced will increase during the coming decade. It is suggested that a vital factor in this development will be the availability to the pilot of up-to-the-minute information on low-level visibility and wind conditions applicable to the runway he is to use. The difficulties of obtaining and forecasting these microclimatic factors are discussed. M.M.

A71-17924 # **Application of Omega to aircraft navigation and traffic control.** E. R. Swanson (U.S. Naval Electronics Laboratory Center, San Diego, Calif.). *Institute of Navigation, Journal,* vol. 24, Jan. 1971, p. 125-128.

Discussion of aspects of the reliability of ambiguity resolution in Omega, the most widely deployed ground-based navigation aid in the world. It is pointed out that propagation statistics support ambiguity resolution over 99% of the time. Actual ambiguity resolution will also depend on prediction errors, but as knowledge of propagation prediction improves, errors will be reduced. Further, optimum information processing can improve ambiguity resolution. M.M.

A71-17925 **VTOL avionics systems.** D. J. Mayes (Smiths Industries, Ltd., Wembley, Middx., England). *Interavia,* vol. 26, Jan. 1971, p. 72-74.

Discussion of the problems presented to the avionics systems designer by the VTOL aircraft, which at the same time gives him an opportunity to apply techniques and new technologies currently being developed. The systems integration in a VTOL aircraft will be extended to the navigation system, since the ability to navigate and fly automatically along paths computed within the aircraft will be essential if the VTOL aircraft is not to be subjected to the delays being experienced by current aircraft in present rigid airways and air traffic procedures. The automatic flight control system for the VTOL is considered, as well as the instrument system. F.R.L.

A71-17951 **The successor of the ILS - The activity of S.C. 117 (La succession de l'I.L.S. - L'activité du S.C. 117).** P. Fombonne (Thomson - CSF, Paris, France). *Navigation* (Paris), vol. 19, Jan. 1971, p. 18-34. In French.

Consideration of various new systems of blind landing which may supersede the present instrument landing system (ILS), which has numerous inherent defects. Because of the frequencies used with the present system, the infrastructure is heavy, and the ground plays an important part in the formation of the radiated lobes. S.C. 117 is a special committee of the Radio Technical Commission for Aeronautics (RTCA). The work of the Signal Format Development Team (SFDT) is reviewed, as well as that of the manufacturers involved. Mobile beam systems and Doppler systems are discussed. F.R.L.

A71-17953 **Blow, blow thou BLC wind.** J. G. Burns and M. Edwards (Hawker Siddeley Aviation, Ltd., Kingston-upon-Thames, Surrey, England). *Flight International,* vol. 99, Jan. 14, 1971, p. 56-59.

Evaluation of the boundary layer controlled (BLC) Phantom and Buccaneer aircraft. Both are twin-Spey powered, two-seat, and radar equipped, make use of three-axis autostability, and immerse a large part of their wing areas in high-pressure boundary layer blowing. In the Phantom the Spey is reheated, in the Buccaneer it is not. Though wingspans and areas are similar, the planforms, thickness/chords and aspect ratios are not. These two features, the wing and the power available, considerably influence the way in which the boundary-layer blowing is applied. The Phantom extracts high lift from its wing by working primarily on the leading edge, whereas the Buccaneer must concentrate its efforts on the trailing edge. F.R.L.

A71-17954 **Concorde NC.** *Flight International,* vol. 99, Jan. 14, 1971, p. 63-68.

Discussion of the numerically controlled (NC) machining on the Concorde, which has been adopted on a very large scale as the only practicable method of producing, within an acceptable time, the integral units that constitute around 65% of the airframe structure. The machining of aluminum-alloy integral units at the Weybridge Division of BAC is described. The structural components considered include the droop nose, the fuselage nose, the forward fuselage, the rear fuselage, the fin and rudder, and the engine-bay and air-intake units. F.R.L.

A71-18015 **Earth satellite systems for marine and transoceanic air navigation and traffic control.** Alfred E. Fiore (U.S. Merchant Marine Academy, Kings Point, N.Y.) and Paul Rosenberg. *(European Navigation Institutes, Quadripartite Meeting, Rome, Italy, May 11-14, 1970.) Navigation,* vol. 17, Fall 1970, p. 234-245. 9 refs.

The applications of earth satellites to navigation and traffic control over ocean routes, particularly the North Atlantic are considered. It is pointed out that marine surface vessels and aircraft could be served simultaneously by the same satellite system. Present marine navigation and traffic control methods are examined, and the advantages of a satellite system are investigated taking into account technological and economic considerations. It is concluded that satellite systems are needed, are technically practical, and are superior to other systems for marine traffic control in confluence areas, en route traffic control of transoceanic aircraft, and search and rescue at sea. Satellite systems are economically justified. It is emphasized that international cooperation is essential for the successful and economic operation of a satellite system for marine and transoceanic air navigation and traffic control. G.R.

A71-18021 # **Transfer functions of a flexible aircraft to turbulence (Fonctions de transfert d'un avion souple à la turbulence).** Gabriel Coupry (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France). *(NATO, AGARD, Meeting, 31st, Tønsberg, Norway, Nov. 5, 1970.) ONERA, TP* no. 894, 1970. 14 p. 5 refs. In French.

Methods for measuring and calculating the transfer of a flexible aircraft to atmospheric turbulence are developed. Applicable turbulence models are briefly reviewed, and it is shown that calculating transfers to isotropic turbulence is hardly more intricate than calculations of transfer to uniform turbulence. Some methods for in-flight measurements of these transfers to turbulence are expounded. Some as yet uncontrolled shortcomings are discussed that impede agreement of theoretical predictions based on these methods with experimental data. M.V.E.

A71-18025 # **Studies of ballistic or aerodynamic flight in the ONERA hypersonic wind tunnels (Etudes du vol balistique ou sustenté dans les souffleries hypersoniques de l'O.N.E.R.A.).** René Cérésuela (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France). *(Deutsche Gesellschaft für Luft- und Raumfahrt, Symposium über den Hyperschallströmungen, Hanover, West Germany, June 4, 1970, Paper DGLR 70-032.) ONERA, TP* no. 877, 1970. 50 p. 20 refs. In German and French.

Brief review of the main features and activities of the hypersonic wind tunnels created ten years ago for the study of ballistic missiles. These wind tunnels are currently used in studies of sounding rocket and scientific-payload reentry problems and, particularly, in aerodynamic research of lift-producing controlled hypersonic flight. Three-dimensional models are tested at incidence angles up to 60 deg. An example is presented of the study of a glider up to Mach 16.5. Problems of kinetic heating and control surface efficiency, relevant to hypersonic aircraft and gliders and particularly to the space shuttle, are also investigated. The example of the study of a 30-mm thick turbulent boundary layer at high Reynolds number (Re equals 20 million) is discussed. M.V.E.

A71-18044 **Deutsche Gesellschaft für Luft- und Raumfahrt, Yearbook 1969 (Deutsche Gesellschaft für Luft- und Raumfahrt, Jahrbuch 1969).** Edited by Hermann Blenk and Werner Schulz. Cologne, Deutsche Gesellschaft für Luft- und Raumfahrt, 1970. 280 p. In German.

The aim of the symposium was to review progress made in fluid mechanics and aerodynamics during the past few years, and to describe some experimental facilities. The papers deal with flight mechanics, automatic flight control, theoretical mechanics, and aerodynamics. A hypersonic low-pressure wind tunnel (Mach numbers from 7 to 25) and a 50-mm diam shock tube (Mach numbers from 3 to 12) at the AVA Göttingen are described. A section deals with DGLR activities in 1969. A subject index and an author index are included. V.P.

A71-18045 **The hypersonic low-pressure wind tunnel of the Aerodynamische Versuchsanstalt Göttingen (Der hypersonische Vakuumwindkanal der Aerodynamischen Versuchsanstalt Göttingen).** Walter Wuest, Georg Koppenwallner, Gerhard Hefer, and Hubert Legge (Aerodynamische Versuchsanstalt, Göttingen, West Germany). In: Deutsche Gesellschaft für Luft- und Raumfahrt, Yearbook 1969 (Deutsche Gesellschaft für Luft- und Raumfahrt, Jahrbuch 1969). Edited by Hermann Blenk and Werner Schulz. Cologne, Deutsche Gesellschaft für Luft- und Ramfahrt, 1970, p. 38-52. 30 refs. In German. Research supported by the Bundesministerium für Bildung und Wissenschaft.

Description of the design and operation of the low-pressure wind tunnel used by the Aerodynamische Versuchsanstalt Göttingen for studies of flow problems in rarefied gases at hypersonic speeds in the range of 7 to 21 Mach. The wind tunnel plant comprises a low-pressure wind tunnel equipped with two test sections, and a high-vacuum tunnel which also has additional installations for the application of the molecular beam technique. Detailed parameters of this experimental tunnel as well as of the necessary special instrumentation for carrying out force, pressure, heat transfer, and temperature measurements are presented. O.H.

A71-18047 **Effect of the ground on the pressure distribution on slender wing bodies with thick cross-sectional shapes (Über den Bodeneinfluss auf die Druckverteilung an Schlanken Flugkörpern mit dicken Querschnittsformen).** Jan von der Decken (Braunschweig, Technische Universität, Braunschweig, West Germany). In: Deutsche Gesellschaft für Luft- und Raumfahrt, Yearbook 1969 (Deutsche Gesellschaft für Luft- und Raumfahrt, Jahrbuch 1969). Edited by Hermann Blenk and Werner Schulz. Cologne, Deutsche Gesellschaft für Luft- und Raumfahrt, 1970, p. 59-76. 26 refs. In German.

Determination of the effect of the ground interference on the pressure distribution on bodies with a low aspect ratio and considerable thickness in an incompressible flow, using a method of calculation based on singularities on the body contour. The method is adapted to the theory of slender bodies simulating the ground effect by the image technique. Both the symmetrical and the asymmetrical flow (angle of attack and angle of side slip, respectively) are considered. Sample calculations have been carried out for two slender bodies with the aspect ratio one with a delta plan form and elliptic cross sections having different thickness ratios. In addition, pressure distributions have been measured for these two bodies at different heights above the ground in a wind tunnel. The calculated pressure distributions and the resulting distributions of lift, drag, lateral force, rolling and yawing moment are found to be in a reasonable agreement with the experiment. O.H.

A71-18048 **Vortex systems of slender bodies and the aerodynamic forces (Wirbelsysteme schlanker Rotationskörper und die aerodynamischen Kräfte).** Martin Fiechter (Institut Franco-Allemand de Recherches, Saint-Louis, Haut-Rhin, France). In: Deutsche Gesellschaft für Luft- und Raumfahrt, Yearbook 1969 (Deutsche Gesellschaft für Luft- und Raumfahrt, Jahrbuch 1969). Edited by Hermann Blenk and Werner Schulz. Cologne, Deutsche Gesellschaft für Luft- und Raumfahrt, 1970, p. 77-85. 21 refs. In German.

Investigation of bodies of revolution of a very high slenderness ratio with cylindrical afterbodies in a subsonic wind tunnel. At angles of attack between 0 and 90 deg, various vortex systems were formed at the lee side of the body: steady, symmetrical, attached - steady, asymmetrically shedding - unsteadily separating. The correlation of these vortex systems to the normal force and pitching moment is illustrated. Allen's cross-flow theory that has been extended to very large angles of attack proves to be adequate for rough calculations. For angles of attack up to 20 deg, the theory based on measurements of vortex impulses yields accurate values. A symmetry limit that is dependent on the fineness ratio and the angle of attack makes it possible to define the initiation of vortex shedding. O.H.

A71-18049 **Extension of the time vector method to equations of motion with real roots and the application of this technique to flight control problems (Erweiterung der Zeitvektormethode auf Bewegungsgleichungen mit reellen Wurzeln und die Anwendung des Verfahrens auf Probleme der Flugregelung).** Reiner Onken (Braunschweig, Technische Universität, Braunschweig, West Germany). In: Deutsche Gesellschaft für Luft- und Raumfahrt, Yearbook 1969 (Deutsche Gesellschaft für Luft- und Raumfahrt, Jahrbuch 1969). Edited by Hermann Blenk and Werner Schulz. Cologne, Deutsche Gesellschaft für Luft- und Raumfahrt, 1970, p. 120-140. 39 refs. In German.

Description of a method which makes it possible to represent differential equations of a system for a pair of eigenvalues in time

vector polygons even if both eigenvalues are real, and its application to the problems of the longitudinal motion of aircraft. The time vector method in its present form is extended by finding a mapping function which is applicable to systems with either complex or real eigenvalues. The multivariable system of the longitudinal motion of aircraft is discussed, and the numerator roots of the transfer functions are interpreted as eigenvalues of an equivalent system in time vector polygons. The characteristic equation of the equivalent system is given by the numerator determinant of the transfer function - i.e., by the parameters of the aircraft. Thus, the effect of these parameters and that of possible feedback terms on the numerator roots may be read from the polygons. Furthermore, the time vector method also allows general statements to be made on the parameter sensitivity as shown by presenting several examples. O.H.

A71-18051 Control of irreversibilities in the mixture of two gas flows (Steuerung der Nichtumkehrbarkeiten bei der Vermischung zweier Gasströme). Bernhard Bauer (Stuttgart, Universität, Stuttgart, West Germany). In: Deutsche Gesellschaft für Luft- und Raumfahrt, Yearbook 1969 (Deutsche Gesellschaft für Luft- und Raumfahrt, Jahrbuch 1969). Edited by Hermann Blenk and Werner Schulz. Cologne, Deutsche Gesellschaft für Luft- und Raumfahrt, 1970, p. 163-193. 15 refs. In German.

Discussion of the feasibility of controlling, and in particular, reducing the irreversibilities in the case of a mixture of two gas flows in a tunnel with a constant cross section of flow. The results obtained for the ideal limiting case of a mixture - i.e., the reversible mixture, are used as a measure. The theoretical results obtained are applied to the problem of a thrust increase of jet engines by admixing air to the exhaust gas, and to the problem of an increased performance of jet compressors. In addition, the thermodynamic estimation of jet engines using energy balances is illustrated on the example of ramjet and turbojet engines. O.H.

A71-18052 Small aircraft gas turbines for helicopters and propeller and jet aircraft - Development and technical details of the various types, their application, and control (Kleine Fluggasturbinen für Hubschrauber, Propeller- und Strahlflugzeuge - Entwicklung und technische Einzelheiten verschiedener Baumuster, ihre Verwendung und Regelung). Edwin J. Th. Kordik. In: Deutsche Gesellschaft für Luft- und Raumfahrt, Yearbook 1969 (Deutsche Gesellschaft für Luft- und Raumfahrt, Jahrbuch 1969). Edited by Hermann Blenk and Werner Schulz. Cologne, Deutsche Gesellschaft für Luft- und Raumfahrt, 1970, p. 194-234. 5 refs. In German.

Review of the current state of development in the economy, design, operation, and control of small gas turbines for the various types of helicopters and powered fixed-wing aircraft. A comprehensive description is first presented of the various types of small gas turbines so far developed, followed by discussions on their advantages in terms of their economy, weight, performance, and operation as compared with piston engines. Close views of their individual main subsystems and components are then given. Finally, detailed attention is given to the respective material problems, synthetic oils used, ignition devices, and fuel control systems of the individual shaft, jet, and turbofan engines considered. O.H.

A71-18214 Design and function of static seals; Institution of Mechanical Engineers, Conference, London, England, December 10, 1970, Proceedings. London, Institution of Mechanical Engineers, 1970. 155 p.

Contents:

Application and problems in the use of quick disconnect dry break couplings in aircraft fuelling. A. D. Radbone, p. 4-19.

Fundamental behavior of rubber seals. W. Fletcher and S. H. Morrell (Rubber and Plastics Research Association of Great Britain, Shrewsbury, Salop, England), p. 127-137.

The design of static seals for various purposes. R. C. Cross, p. 138-149.

Piston expulsion seals for package liquid rockets. W. E. Wheeler, p. 150-157.

A71-18215 # Application and problems in the use of quick disconnect dry break couplings in aircraft fuelling. A. D. Radbone. In: Design and function of static seals; Institution of Mechanical Engineers, Conference, London, England, December 10, 1970, Proceedings. London, Institution of Mechanical Engineers, 1970, p. 4-19.

Discussion of the dry break quick connect/disconnect coupling, used normally in the fueling of all jet and turboprop aircraft in airline service throughout the world, through which the fuel is transferred under pressure. The coupling operation is described, as well as safety design features incorporated in the coupling. The importance of its being able to withstand shock pressures if the fuel flow is shut down is emphasized. Attention is given to the various factors which must be considered when selecting the nose seal, and various types of seals are described. Problems arising with these seals are discussed. F.R.L.

A71-18222 # Load-transfer and load-diffusion in elastostatics. Eli Sternberg (California Institute of Technology, Pasadena, Calif.). In: U.S. National Committee on Theoretical and Applied Mechanics, U.S. National Congress of Applied Mechanics, 6th, Harvard University, Cambridge, Mass., June 15-19, 1970, Proceedings. New York, American Society of Mechanical Engineers, 1970, p. 34-61. 24 refs. Contract No. Nonr-220(58).

Summary of a recent sequence of theoretical investigations of plane and spatial load-transfer problems in linear elastostatics. The two-dimensional problems dealt with have a particular relevance to aircraft structures, while those concerning the transfer of load between a bar and a three-dimensional elastic medium are primarily of interest in connection with civil engineering structures and have a bearing on the mechanics of fiber-reinforced materials. An attempt is made to assess the role of alternative mathematical models in the treatment of the physical problems under consideration, to sketch the essential features of the required analysis, and to discuss the principal results obtained. M.V.E.

A71-18227 # Study for the determination of transonic flow around constant curvature wing contours in a uniform asymptotic stream without incidence, at Mach number smaller than 1. III (Studio per la determinazione del flusso transonico attorno a profili alari a curvatura costante, in corrente asintotica uniforme, senza incidenza, con numero di Mach smaller than 1. III). Magda Rolando Leschiutta. *Torino, Accademia delle Scienze, Classe di Scienze Fisiche, Matematiche e Naturali, Atti,* vol. 104, Jan.-Feb. 1970, p. 135-144. In Italian.

Extension of the results of previous investigations to the case of an infinite class of wing contours shaped like an arc of a circle whose angles theta sub o of the leading edge are equivalent to pi/2s, s being an integer. It is shown to what order of approximation the condition that the curvature should be constant on the contour makes it possible to determine the stream function. This function is then calculated explicitly in the above mentioned order of approximation. M.M.

A71-18248 # A new electric vertical speed indicator. I (Ein neues elektrisches Variometer. I). Ernst Iselin. *Aero-Revue,* Jan. 1971, p. 29. In German.

Discussion of the principles underlying the operation of vertical speed indicators used in balloons and gliders. Only conventional barometric vertical speed indicators are considered. The relatively slow response of these devices is explained, and the resulting disadvantages are pointed out. Appropriate measures to overcome these disadvantages are examined. O.H.

A71-18249 **Wind tunnel measurements on airfoils with flaps at medium Reynolds numbers. II (Windkanalmessungen an Profilen mit Klappen bei mittleren Reynoldszahlen. II).** D. Althaus (Stuttgart, Universität, Stuttgart, West Germany). *(Organisation Scientifique et Technique Internationale du Vol à Voile, Congress, 12th, Alpine, Tex., June 27-July 4, 1970.) Aero-Revue,* Jan. 1971, p. 37-39. In German.

Experimental investigation of performance characteristics of horizontal and vertical stabilizers at medium Reynolds numbers. Data obtained in wind tunnel measurements are evaluated to determine the effects of airfoil and flap characteristics on the resistance of the stabilizers. O.H.

A71-18250 **Variable camber flap automatics. I (Wölbklappen-Automatik. I).** Günter Cichon. *(Organisation Scientifique et Technique Internationale du Vol à Voile, Congress, 12th, Alpine, Tex., June 27-July 4, 1970.) Aero-Revue,* Jan. 1971, p. 39, 40. In German.

Description of relatively simple automatic equipment designed for gliders, which makes it possible to set the aerodynamically most favorable position of variable camber flaps gradually at any moment during flight. Three possible basic principles are considered: a combined mechanical and electrical, a combined mechanical and electronic, and an electronic approach. O.H.

A71-18307 # **The directional stability of helicopter in rectilinear flight.** Takashi Murayama (Defense Academy, Yokosuka, Japan) and Sigeru Yamamura. *Japan, Defense Academy, Memoirs,* vol. 10, Sept. 1970, p. 327-336.

Discussion of the directional responses of a single-rotor helicopter in a rectilinear steady flight with a constant angle of side slip. Three different flight conditions, i.e., with a constant angle of side slip equal to zero, less than zero, and upwards of zero, are considered. It is found that in general, a single-rotor helicopter has two modes of directional response, i.e., oscillatory convergence and divergence with time, according to the values of the constant angle of side slip. In all the cases the eigen control can make them to converge, even in the case of oscillatory divergence. O.H.

A71-18308 # **The method of eigen control for a second order system with time varying parameters.** Takashi Murayama (Defense Academy, Yokosuka, Japan) and Sigeru Yamamura. *Japan, Defense Academy, Memoirs,* vol. 10, Sept. 1970, p. 337-347.

Description of a method for making stable second order systems with time varying parameters. The special case of a dynamically unstable second order system with time varying parameters is considered, which is made stable using only the proportional control with a time varying coefficient; no derivative control is used. By means of this technique, the system is made stable even if the damping coefficient is negative. The method can be applied to aircraft autopilot systems; while most of the conventional autopilot systems are operated by obtaining signals from an attitude gyro and a rate gyro, no rate gyro is necessary when utilizing this method. O.H.

A71-18325 # **Range and optimum angle of attack for aircraft flying in a windy atmosphere (Distanţa de zbor şi unghiul de incidentă optim al avioanelor în atmosfera cu vînt).** Alexandru Codoban (Bucureşti, Institutul Politechnic, Bucharest, Rumania). *Revista Transporturilor,* vol. 17, Oct. 1970, p. 443-448. 5 refs. In Rumanian.

Derivation of relationships for calculating the possible range for an aircraft in an atmosphere with a wind of constant direction and intensity. A method is developed for calculating the angle of attack at which the flight must be carried out to achieve maximum range. A method is established for determining the amount of fuel necessary for the flight under windy conditions over a given distance. The angle of attack is assumed to be constant throughout the flight. M.M.

A71-18408 # **Development of an aerospace system for agriculture.** Thomas J. Army, S. MacCallum King (International Minerals and Chemicals Corp., Libertyville, Ill.), and Ronald O. Aines. In: Aerospace science and agricultural development; American Society of Agronomy, Crop Science Society of America, and Soil Science Society of America, Annual Meeting, Detroit, Mich., November 9-14, 1969, Proceedings. (Edited by M. F. Baumgardner. Madison, Wis., American Society of Agronomy (ASA Special Publication Series, No. 18), 1970, p. 27-35. 6 refs.

Discussion of the development of an improved agricultural information and advisory service based on technological advances in both remote sensing and computer sciences and making use of satellites and aircraft. A three-pronged approach to the development of an aerospace information system for midwestern agriculture as a first step is discussed. The three essential components of this proposed effort are a research program, a pilot applications system utilizing aircraft and satellites, and a user educational-involvement program. The research program will need to be sufficiently general to investigate effective data distribution and utilization as well as data acquisition. A program for managing agricultural resources through data obtained via remote sensing is to be tested. G.R.

A71-18409 # **Accelerating international agricultural development with aerospace remote sensing.** Donald L. McCune (Tennessee Valley Authority, Muscle Shoals, Ala.). In: Aerospace science and agricultural development; American Society of Agronomy, Crop Science Society of America, and Soil Science Society of America, Annual Meeting, Detroit, Mich., November 9-14, 1969, Proceedings. Edited by M. F. Baumgardner. Madison, Wis., American Society of Agronomy (ASA Special Publication Series, No. 18), 1970, p. 37-48.

Discussion of the benefits which could be derived from a worldwide remote sensing system using satellites or high-flying aircraft in connection with computer data-processing techniques giving particular attention to advantages for the less developed areas of the world. The importance of a full acceptance of such a system by the nations of earth is pointed out, and organizational approaches for creating such a system through the UN are considered. Worldwide potentials of aerospace remote sensing are examined taking into consideration the availability of new improved equipment. Various fields which would benefit from a global remote sensing system are discussed including weather forecasting, survey of world crops, national and regional planning, vegetation mapping, characterization and mapping of soils, inventory of water resources, monitoring irrigation agriculture, and animal agriculture. G.R.

A71-18423 • **An evaluation of low-visibility landing systems by simulation.** Paul S. Rempfer, Lloyd E. Stevenson, and Joseph S. Koziol, Jr. (NASA, Electronics Research Center, Cambridge, Mass.). *VertiFlite,* vol. 17, Jan. 1971, p. 4-7, 10, 11. 9 refs.

Discussion of a fixed-base simulation evaluation of various low-visibility landing systems for helicopters. A flexible digital multimode landing system was developed, which allowed the pilot to select any one of a variety of landing systems. These landing systems consisted of a fully-automatic system and six manual systems. All systems considered are found operationally acceptable for a straight-in 0.1-radian glide slope and localizer mission with visual breakout prior to 150 ft of altitude. The automatic system is judged to have the best performance. G.R.

A71-18463 **Integrated-Drive Generator for aircraft accelerates trend toward less weight and longer life.** J. K. Taulbee (Westinghouse Electric Corp., Lima, Ohio). *Westinghouse Engineer,* vol. 31, Jan. 1971, p. 15-19.

Discussion of a new line of aircraft generators in which considerable savings in weight and an increased life were achieved primarily by a new cooling method. The generators are cooled by oil sprayed directly on the heat-generating components instead of by air, or by oil calculated through passages. The generators were developed

for the new Integrated Drive Generator (IDG) system, in which the generator is integrated into the constant-speed drive. Details concerning the flow of the oil in the IDG are presented, and the location of the spray nozzles is shown. G.R.

A71-18471 # Luminometer numbers of particular hydrocarbons and reactive fuels (Liuminometricheskie chisla individual'nykh uglevodorodov i reaktivnykh topliv). B. A. Englin and M. E. Reznikov. *Khimiia i Tekhnologiia Topliv i Masel,* vol. 15, no. 11, 1970, p. 52-56. 7 refs. In Russian.

Determination of the luminometer numbers of 32 different hydrocarbons and 25 samples of the industrial fuels TS-1, T-7, and T-1. It is shown that the luminometer number of hydrocarbons is associated with their structure. The highest values of this number are exhibited by hydrocarbons of a regular structure, and the lowest values are found in aromatic hydrocarbons, particularly bicyclic ones. The luminometer numbers of paraffin hydrocarbons decrease with increasing molecular weight and higher numbers of hydrocarbon branches. Z.W.

A71-18481 * # Flight investigation of a tilt-wing VTOL aircraft in the terminal area under simulated instrument conditions. Henry L. Kelley and Robert A. Champine (NASA, Langley Research Center, Hampton, Va.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 9th, New York, N.Y., Jan. 25-27, 1971, Paper 71-7.* 13 p. 9 refs. Members, $1.50; nonmembers, $2.00.

Hovering and low-speed flight capabilities of VTOL aircraft offer advantages in an air transport system through operation into confined terminal areas and through continued operation during near-zero visibility conditions. A flight investigation utilizing a tilt-wing concept VTOL transport aircraft was recently conducted by the NASA Langley Research Center to help provide a technical background on which to design an operation of this type. The purpose of this investigation was to identify major tilt-wing concept related factors, and handling-quality and cockpit-display factors influencing the precision low-speed instrument-approach task. Two levels of stability augmentation and cockpit displays were investigated. The results indicated that the approach steepness was limited by an insufficient buffet-free descent-rate capability within the 30- to 60-knot airspeed range. Also, modifications in stability augmentation from a basic angular-rate damping system to an attitude system, and modification of the cockpit display to include VTOL-type flight-director information significantly improved the low-speed instrument-approach capability through a reduced pilot workload and improved tracking smoothness and precision. (Author)

A71-18482 # A critical review of canard relative to aft horizontal tail based on low- and high-speed tunnel tests of a fighter/attack configuration. R. B. Eberle, R. T. Stancil, and W. C. Fowler (Vought Aeronautics Corp., Dallas, Tex.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 9th, New York, N.Y., Jan. 25-27, 1971, Paper 71-8.* 11 p. Members, $1.50; nonmembers, $2.00.

A horizontal tail was wind tunnel tested on a model in the aft and canard locations at Mach numbers between 0.18 and 2.0. The maximum usable, trimmed lift coefficient and maximum L/D of the canard arrangement were equal to or less than those of the aft tail for the normal condition of fixed-control static longitudinal stability (10 per cent static margin at the critical Mach number). However, if the airplane CG is moved aft and stability obtained artificially, the canard loads change favorably and make the trimmed maximum lift coefficient and maximum L/D moderately superior to those of the aft tail. (Author)

A71-18483 * # The use of sensitivity analysis in designing optimal gust alleviation systems. Ray V. Hood and Raymond C. Montgomery (NASA, Langley Research Center, Hampton, Va.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 9th, New York, N.Y., Jan. 25-27, 1971, Paper 71-9.* 7 p. Members, $1.50; nonmembers, $2.00.

In this report, modern optimal control theory is used in conjunction with sensitivity analysis to obtain a simple control system that minimizes undesirable longitudinal motions induced by atmospheric turbulence. This control system consisted of feedbacks of all longitudinal state variables to the elevator. The elevator was connected mechanically, with a linear gear ratio, to a wing flap. Optimal feedback gains and gear ratios are presented for two cases - an altitude hold case and an attitude hold case. The feedback gains were determined using linear regulator theory. The optimal gains and ratios for each case are presented for a large transport aircraft and a high-performance aircraft. A simple expression for determining the optimal gear ratios, which is valid for both aircraft considered, is presented for the altitude hold and attitude hold cases. (Author)

A71-18484 # The parabolic wing tip in subsonic flow. Peter F. Jordan (Martin Marietta Corp., Research Institute for Advanced Studies, Baltimore, Md.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 9th, New York, N.Y., Jan. 25-27, 1971, Paper 71-10.* 15 p. 11 refs. Members, $1.50; nonmembers, $2.00. Contract No. AF 44(620)-69-C-0096.

Study of the theory of thin lifting airfoils of finite span in linear subsonic flow. The nature of the pressure singularity at a subsonic parabolic wing tip is described by presenting the complete solution for the circular wing in incompressible flow. F.R.L.

A71-18485 # Slat design by a semi-inverse technique. J. E. O'Pray (USAF, Rocket Propulsion Laboratory, Edwards AFB, Calif.) and P. B. S. Lissaman (Northrop Corporate Laboratories, Hawthorne, Calif.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 9th, New York, N.Y., Jan. 25-27, 1971, Paper 71-11.* 11 p. 6 refs. Members, $1.50; nonmembers, $2.00.

A method of generating high-lift nose slats for an arbitrary airfoil is developed, assuming desirable main airfoil pressures are specified from boundary layer considerations. Using conformal transformations, slats are developed which generate pressures having least square matching to that desired. Approximate slat position and chord are selected, with parameters like slat nose radius, thickness, camber, angle of attack, either prescribed or generated by program. Each trial case takes about 20 seconds on IBM 360/75, pressures comparing well with exact direct airfoil and slat solution. As a design tool, the method rapidly develops slat families of desired performance. (Author)

A71-18488 # Matched asymptotic solutions for optimum lift controlled atmospheric entry. Yun-Yuan Shi (McDonnell Douglas Astronautics Co., Huntington Beach, Calif.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 9th, New York, N.Y., Jan. 25-27, 1971, Paper 71-21.* 17 p. 25 refs. Members, $1.50; nonmembers, $2.00. Research supported by the McDonnell Douglas Astronautics Independent Research and Development Fund.

This paper considers the problem of optimal lift control of a hypersonic lifting body during atmospheric entry for the case where the drag coefficient is a function of the angle of attack and the atmospheric density is an arbitrary function of altitude. It is a generalization of an earlier investigation. The solution obtained is valid for entering the planetary atmosphere from the Keplerian region, as well as from low altitudes. The method of matched asymptotic expansions was employed, and separate expansions were derived for the Keplerian region (where the gravitational force is dominant) and for the aerodynamic region (where the aerodynamic forces are dominant). The Lagrange multipliers as well as the state variables were obtained in closed form to the first order in both expansions and were matched in the overlap domain. A method for estimating the order of magnitude of Lagrange multipliers in various regions was discussed and will be useful in applying singular perturbation methods to a wider class of optimal control problems.

It was shown that in the case of unbounded control the lift variation can be classified into four different types of programs depending on the terminal altitude. These results were compared with the numerical solutions obtained by the method of steepest descent. For the case of bounded control, it was shown that there exist 12 different sequences of arcs which essentially reduce to those obtained in an earlier study in the limit as the drag coefficient becomes independent of angle of attack. (Author)

A71-18489 * # **Performance limitations of an inertial aircraft lateral guidance system subject to random gusts.** Duncan MacKinnon and Paul Madden (Charles Stark Draper Laboratory, Cambridge, Mass.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 9th, New York, N.Y., Jan. 25-27, 1971, Paper 71-22.* 9 p. 8 refs. Members, $1.50; nonmembers, $2.00. Contract No. NAS 12-602.

Inertial navigators are becoming a common instrument on transport aircraft. In addition to its navigation value, inertial position, velocity and acceleration information, suitably bounded in error by radio measurement, is ideal for application in flight path control systems. While optimal control solutions are desirable, the necessity of estimating difficult to measure state elements such as sideslip angle complicates the solution. As a result it is useful to investigate simpler systems utilizing a subset of the state for feedback purposes. This paper uses parameter optimization to explore the performance limitations of a class of incomplete state feedback inertial data based lateral control systems in a stochastic gust environment. Configurations using aileron or differential spoiler are compared. (Author)

A71-18499 # **Turbulent heat transfer measurements on a blunt cone at angle of attack.** George F. Widhopf (Aerospace Corp., San Bernardino, Calif.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 9th, New York, N.Y., Jan. 25-27, 1971, Paper 71-38.* 13 p. 16 refs. Members, $1.50; nonmembers, $2.00.

Measured turbulent heat transfer rates on the conical surface of a blunt nine-degree half-angle cone in a nitrogen flow at a freestream Mach number 10.7 and various angles of attack. The boundary layer was tripped in order to attain turbulent flow over the model. Detailed distributions of the heat transfer rate and surface pressure were obtained in the circumferential as well as the axial directions. Turbulent heat transfer rates computed along inviscid surface streamlines, wherein the streamline pattern is determined utilizing the experimental pressure distributions, are compared to the data. Good agreement is obtained in the regions where the assumption of neglecting the effect of entropy swallowing utilized in the analysis is valid. The turbulent heat transfer formulation, as proposed by Vaglio-Laurin as applicable in three-dimensional flows, is shown to be a good approximation, and the influence of streamline spreading is demonstrated as well as the relative accuracy of equivalent cone techniques. The results of numerical calculations of the surface pressure are compared to the data, where good agreement is achieved, except in regions where viscous phenomena become important. (Author)

A71-18501 # **Design of maximum thrust plug nozzles for fixed inlet geometry.** Robert P. Humphreys (U.S. Air Force Academy, Colorado Springs, Colo.), H. Doyle Thompson, and Joe D. Hoffmann (Purdue University, Lafayette, Ind.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 9th, New York, N.Y., Jan. 25-27, 1971, Paper 71-40.* 11 p. 11 refs. Members, $1.50; nonmembers, $2.00. Contract No. AF 33(615)-67-C-1068.

The calculus of variations is used to obtain the design equations for the contour of maximum thrust plug nozzles with a fixed inlet geometry and a specified geometric constraint. The optimum values of the injection angle at the throat and the cowl lip radius are determined by a parametric study. The problem is formulated to maximize the pressure thrust integral along the supersonic portion of the plug surface and includes the effect of base pressure. The analysis is carried out for irrotational flow and includes boundary layer effects. A method is presented to determine if a given contour is an optimum, and a relaxation technique is used to obtain a solution to the resulting design equations. Numerical examples are presented for a fixed plug length and mass flow rate. The results of a parametric study to determine the optimum cowl lip radius and injection angle are presented and the resulting optimum nozzle is compared to one designed by Rao's method. The importance of the transonic flow analysis and base pressure model are illustrated. (Author)

A71-18512 # **Sharp and blunt cones at angle of attack in supersonic nonuniform free streams.** Clark H. Lewis (Virginia Polytechnic Institute and State University, Blacksburg, Va.), F. R. DeJarnette (North Carolina State University, Raleigh, N.C.), F. G. Moore, and Roie Black. *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 9th, New York, N.Y., Jan. 25-27, 1971, Paper 71-51.* 17 p. 7 refs. Members, $1.50; nonmembers, $2.00. Contract No. AF 33(615)-70-C-1015.

Effects of supersonic axisymmetric wake-like and two-dimensional shear nonuniform free-stream flows on the inviscid flow fields and aerodynamic coefficients of sharp and spherically blunted cones were studied at zero and nonzero angles of attack. Inverse blunt body and two- and three-dimensional method of characteristics were modified to treat nonuniform free streams. Entropy layers and strong adverse surface pressure gradients were generated along the sharp cones. Surface pressures and aerodynamic coefficients of sharp cones were found to correlate well with a tangent cone theory for nonuniform free streams. Effects on sharp cone aerodynamic coefficients were studied for cones off the axis of symmetry of the wake flow. Comparisons are presented between sharp and blunt cone flow fields in wake flows at zero angle of attack. (Author)

A71-18515 * # **Three-dimensional flow around blunt bodies with sharp shoulders.** R. W. Barnwell (NASA, Langley Research Center, Hampton, Va.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 9th, New York, N.Y., Jan. 25-27, 1971, Paper 71-56.* 12 p. 11 refs. Members, $1.50; nonmembers, $2.00.

An analysis of inviscid, compressible flow past sharp-shouldered blunt bodies at angle of attack is presented, and a time-dependent, finite-difference technique for calculating flow of this type is described. Particular attention is paid to the region of transonic flow near the shoulder. Results obtained with the present technique are compared with experiment for a supersonic free stream. (Author)

A71-18516 # **Hypersonic boundary layer studies on a spinning sharp cone at angle of attack.** Harry A. Dwyer (California, University, Davis, Calif.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 9th, New York, N.Y., Jan. 25-27, 1971, Paper 71-57.* 10 p. 14 refs. Members, $1.50; nonmembers, $2.00.

An investigation has been carried out to study and calculate the hypersonic, laminar, three-dimensional boundary layer flow over a spinning right-circular cone at relatively small angles of attack. The main emphasis in the study was directed towards the investigation of the influence of spin on the boundary layer structure, and on the difficulties spin causes for the computational methods. The spinning-cone problem was chosen because it exhibits many features which are fundamental to three-dimensional boundary layers, and also because spin can cause a situation where the boundary layer approximation breaks down near the windward and leeward cone generators. This flow problem pushes the current finite difference methods for solving three-dimensional boundary layer flows to their limit and has lead to new definitions of 'explicit' and 'implicit' finite difference methods for three-dimensional boundary layers. New

methods for extending the boundary layer approximation have been proposed in the paper. Also, from the results of the calculations, conclusions can be made concerning the magnitude of the side or 'Magnus' force caused by the spinning of the body. (Author)

A71-18517 # **Comparison of SAGE/Buic and Kalman filters for air traffic control.** L. J. Bonin (Lockheed Electronics Co., Houston, Tex.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 9th, New York, N.Y., Jan. 25-27, 1971, Paper 71-58.* 7 p. 11 refs. Members, $1.50; nonmembers, $2.00.

A conservative radar model is used to determine the relative accuracy of the SAGE/Buic and Kalman filters for aircraft tracking. The Kalman filter is shown to improve the accuracy of aircraft ground position and speed by factors of five and 10, respectively. It also provides an altitude estimate with an accuracy of 1000 feet using only conventional azimuth-scanning radar. Methods of improving the altitude accuracy with elevation-scanning radar and providing collision-avoidance information from three-way range data are also presented. (Author)

A71-18524 # **Uniform electrical excitation of large volume high pressure gases with application to laser technology.** Alan E. Hill (USAF, Weapons Laboratory, Kirtland AFB, N. Mex.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 9th, New York, N.Y., Jan. 25-27, 1971, Paper 71-65.* 6 p. 5 refs. Members, $1.50; nonmembers, $2.00.

Description of aerodynamic techniques whereby uniform 50 liter volume 150 kW electric discharges are produced in a near sonic carbon dioxide-nitrogen-helium flowstream. These discharges are spacially diffuse over the entire volume and do not depend on wall diffusion at pressures up to 150 torr and electrical power load densities exceeding 250 kW/lb mass/sec. A 17 pass 5.6 x 76 x 100 cm laser amplifier flowing .55 lb/sec closed cycle produced 19.1 kW continuous single mode 10.6 micron radiation with 24% electrical-optical efficiency. G.R.

A71-18549 # **Airfoils in two-dimensional nonuniformly sheared slipstreams.** G. R. Ludwig and J. C. Erickson, Jr. (Cornell Aeronautical Laboratory, Inc., Buffalo, N.Y.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 9th, New York, N.Y., Jan. 25-27, 1971, Paper 71-94.* 9 p. 13 refs. Members, $1.50; nonmembers, $2.00. Grant No. DA-HC-04-67-C-0071.

A theoretical and experimental program has been conducted to investigate the aerodynamics of an airfoil in a two-dimensional nonuniformly sheared slipstream. A mathematical model has been developed to predict airfoil pressure distributions in such a slipstream and has been used successfully for slipstreams with moderate shear. Pressure distributions over a wide angle of attack range have been measured experimentally on an airfoil at each of seven different locations in a highly sheared two-dimensional slipstream. Study of the pressure distributions obtained on the airfoil at a location slightly above the flow centerline and also at a location slightly below the flow centerline indicates that the large effects on stalling characteristics are due to differences in the upper surface pressure distributions. These pressure distributions are affected by the freestream shear. Moreover, in the data obtained for airfoils located near the flow centerline, the differences in the lift appear to be caused primarily by differences in the stagnation pressure of the streamline which intersects the airfoil. This stagnation pressure is a function not only of airfoil location relative to the slipstream, but also of the angle of attack of the airfoil. (Author)

A71-18550 # **Nonlinear vortex interactions on wing-canard configurations.** David Finkleman (USAF, Frank J. Seiler Research Laboratory, Colorado Springs, Colo.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 9th, New York, N.Y., Jan. 25-27, 1971, Paper 71-95.* 15 p. 27 refs. Members, $1.50; nonmembers, $2.00.

Sacks's method of simulating vortex sheets with distributions of discrete vortices has been applied to the study of the interaction of a slender wing with a nearby canard surface. The canard is detrimental to both lift and static longitudinal stability. The extent of canard vortex sheet rollup is shown to be important in the interaction. Downward canard deflection may lead to increases in lift of the entire configuration, and it is observed that for small vertical separations between the surfaces the forward portion of a pointed wing preceded by a canard is ineffective in producing lift. (Author)

A71-18551 # **The flow around wing sections with high-lift devices.** D. N. Foster (Royal Aircraft Establishment, Farnborough, Hants., England). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 9th, New York, N.Y., Jan. 25-27, 1971, Paper 71-96.* 9 p. 9 refs. Members, $1.50; nonmembers, $2.00.

A combined theoretical and experimental study has been made of the two-dimensional flow around a wing with a slat and slotted flap. Detailed measurements of the surface pressures and of the characteristics of the viscous layer were obtained, while special care was taken to ensure that conditions were as close as possible to two-dimensional flow. Comparisons have been made with values calculated for inviscid flow, to show how the theoretical effect of variation of the position of the slat and flap was modified by viscous effects. These have allowed the flow for the position of the slat or flap which gives optimum aerodynamic performance to be described, and consideration has been given to the calculation methods required to predict this position, and the corresponding flow. Finally, some suggestions have been made as to how the characteristics of the slat and flap are likely to be affected by changes of Reynolds number, and how this work might be extended to the three-dimensional flow on a sweptback wing. (Author)

A71-18552 # **Federal Aviation Administration full-scale aircraft vortex wake turbulence flight test investigations - Past, present, future.** Leo J. Garodz (FAA, National Aviation Facilities Experimental Center, Atlantic City, N.J.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 9th, New York, N.Y., Jan. 25-27, 1971, Paper 71-97.* 25 p. 12 refs. Members, $1.50; nonmembers, $2.00.

This is a brief summary/status report on flight test programs which are designed to gather quantitative data on aircraft vortex characteristics for air traffic control application. Aircraft tested to date include the Sikorsky S-58 helicopter; the Boeing 747, 727 and 707; the Douglas DC8-63, DC8-33 and DC9-10; the Lockheed C5A, C-141; and the Convair CV-880 aircraft. Future vortex investigation flight tests will include the Douglas DC-10, Lockheed L1011 and the Concorde aircraft. Test techniques discussed are the aircraft tower flybys, vortex penetrations with suitably instrumented probe aircraft and vortex probing with an airborne rake-type airflow measurement system suspended from a second aircraft. Vortex flow visualization requirements and problems are covered for both aircraft and tower installations. Significant test results to date indicate (1) higher tangential velocities and smaller core diameters than certain theories predict and (2) that aircraft operations with some degree of landing flap deflection accelerates vortex instability onset and decay. (Author)

A71-18553 # **Application of the method of integral relations to transonic airfoil problems.** Tsze C. Tai (U.S. Naval Material Command, Ship Research and Development Center, Washington, D.C.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 9th, New York, N.Y., Jan. 25-27, 1971, Paper 71-98.* 9 p. 13 refs. Members, $1.50; nonmembers, $2.00.

The Dorodnitsyn method of integral relations is modified to develop a numerical procedure for solving supercritical flows past an arbitrary airfoil. This modification allows the number of strips used to be considerably higher than the order of polynomial which

approximates the integrands, and the free-stream boundary to be set at 'infinity.' The numerical procedure, however, involves iterative processes of a steady flow. Using first and second-order polynomial approximations, exploratory results compare fairly well with those obtained by the unsteady finite difference scheme for a circular-arc airfoil at a freestream Mach number of 0.85 and very well with experimental data for an NACA 0012 airfoil at a freestream Mach number of 0.75. (Author)

A71-18554 • # A systematic development of the supersonic flow fields over and behind wings and wing-body configurations using a shock-capturing finite-difference approach. Paul Kutler and Harvard Lomax (NASA, Ames Research Center, Moffett Field, Calif.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 9th, New York, N.Y., Jan. 25-27, 1971, Paper 71-99.* 12 p. 27 refs. Members, $1.50; nonmembers, $2.00.

Three-dimensional inviscid, supersonic flow containing primary and embedded shock and expansion waves is determined over and behind simple wings and wing-body combinations. The nonlinear gas-dynamic equations are differenced according to a method proposed by MacCormack which is a variation of the Lax-Wendroff technique. Progressive development toward aircraft-like configurations is made by obtaining results for the flow over cones at large incidences, conical wing-body combinations, the flow over and behind pointed ogives, cone-cylinders, and planar delta wings at angle of attack. Comparisons are made with other applicable theories and when possible with experiment. (Author)

A71-18555 • # Hypersonic transitional and turbulent flow studies on a lifting entry vehicle. C. H. Young, A. M. Roberge (General Dynamics Corp., Convair Aerospace Div., San Diego, Calif.), and D. C. Reda (NASA, Ames Research Center, Moffett Field, Calif.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 9th, New York, N.Y., Jan. 25-27, 1971, Paper 71-100.* 13 p. 36 refs. Members, $1.50; nonmembers, $2.00.

An experimental and analytical program was conducted to obtain turbulent heat transfer and boundary layer transition data on a lifting entry configuration at Mach 10. Heat transfer and static pressure distributions, shadowgraphs, and boundary layer flow field surveys were obtained. Transitional and turbulent data were taken with and without spherical trip elements over a range of angle of attack from minus 10 to 60 deg and freestream unit Reynolds numbers from 300,000 to 2,400,000 per foot. Transition onset, transition zone heat transfer and extent, and turbulent heat transfer were correlated with existing theories and criteria. Transition occurred at much lower Reynolds numbers on the flat lower surface than have been observed on sharp or blunt cones under similar operating conditions. No transition was observed on the conical upper surface, even at negative vehicle angles of attack. (Author)

A71-18572 # Results of a strong interaction, wake-like model of supersonic separated and reattaching turbulent flows. Louis G. Hunter, Jr. (Avco Corp., Avco Systems Div., Wilmington, Mass.) and Barry L. Reeves. *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 9th, New York, N.Y., Jan. 25-27, 1971, Paper 71-128.* 14 p. 28 refs. Members, $1.50; nonmembers, $2.00.

Results of an interaction theory for supersonic separated and reattaching turbulent boundary layers are presented and compared with recent experiments for flow past a compression ramp. Effects of ramp angle, Mach number, Reynolds number, and upstream pressure gradient are considered for situations where the critical point is located upstream of the trailing edge. When the critical point falls downstream of the trailing edge the whole region of separated flow is influenced by ramp length. In these 'short ramp' flows the peak ramp pressure attains a maximum at a critical ramp angle and then decreases with increasing angle. It is shown that this effect is responsible for the spanwise pressure distributions measured by Whitehead and Keyes for flow over a delta wing with a trailing edge flap. Results are also presented for a turbulent boundary layer-shock wave interaction. (Author)

A71-18573 # Hypersonic laminar boundary-layer separation on a slender cone at angle of attack. Kenneth F. Stetson and Edward S. Ojdana, Jr. (USAF, Fluid Dynamics Facilities Research Laboratory, Wright-Patterson AFB, Ohio). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 9th, New York, N.Y., Jan. 25-27, 1971, Paper 71-129.* 23 p. 23 refs. Members, $1.50; nonmembers, $2.00.

Wind tunnel experiments with a 5.6 degree half angle cone at a freestream Mach number 14.2 indicated that the three-dimensional separation bubble concept was not the correct flow field model for these data. Based upon data consisting of surface pressure measurements, pitot pressure surveys, and surface oil flow patterns a new model for hypersonic three-dimensional separation is proposed. This model contains symmetrical supersonic helical vortices with an attachment line on the most leeward ray. The vortices are in contact with the surface, and there are no subsonic reverse flow or singular points associated with the vortex pattern. (Author)

A71-18576 • # Advances in hypersonic extrapolation capability - Wind tunnel to flight. J. A. Penland (NASA, Langley Research Center, Hampton, Va.) and D. J. Romeo (Cornell Aeronautical Laboratory, Inc., Buffalo, N.Y.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 9th, New York, N.Y., Jan. 25-27, 1971, Paper 71-132.* 6 p. 7 refs. Members, $1.50; nonmembers, $2.00.

Description of recent results on the capability of hypersonic extrapolation obtained on a hypersonic cruise aircraft configuration at Mach 8 in the Cornell Aeronautical Laboratory hypersonic shock tunnel over a Reynolds number range from a completely laminar boundary layer to a predominantly turbulent one. The significant factors which can affect extrapolation of wind tunnel data at subscale Reynolds numbers to flight values are identified. The capability for predicting turbulent flight Reynolds number data from wind tunnel data under laminar and transitional boundary layer conditions is shown. It is pointed out that the factor that significantly affects extrapolation of hypersonic subscale Reynolds number data to flight Reynolds number values is the skin friction. M.M.

A71-18578 # Flight test base pressure results at hypersonic Mach numbers and high Reynolds numbers in turbulent flow - Implications to ground test simulation requirements. J. M. Cassanto (GE Aerodynamics Laboratory, King of Prussia, Pa.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 9th, New York, N.Y., Jan. 25-27, 1971, Paper 71-134.* 6 p. 17 refs. Members, $1.50; nonmembers, $2.00. Contract No. AF 04(694)-350.

Recent full scale flight test base pressure results on a slender cone in turbulent flow indicate: (1) no significant radial base pressure gradients exist; (2) base pressure ratio is relatively constant for order of magnitude changes in Reynolds number. The present flight results and those of other investigators correlate well when the ratio of base to cone pressure are plotted versus the local Mach number preceding the base. Flight Reynolds numbers are an order of magnitude higher than the simulation capability of ground test facilities at freestream Mach number 20. This suggests that a goal/requirement for ground test facilities might be to increase the Reynolds number capability by a factor of 10 at freestream Mach number 20, or a sufficient amount to achieve a turbulent boundary layer. (Author)

A71-18579 # **Modeling of the turbulence structure of the atmospheric surface layer.** T. R. Sundaram, G. R. Ludwig, and G. T. Skinner (Cornell Aeronautical Laboratory, Inc., Buffalo, N.Y.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 9th, New York, N.Y., Jan. 25-27, 1971, Paper 71-136.* 11 p. 22 refs. Members, $1.50; nonmembers, $2.00. AEC Contract No. AT (30-1)-4038.

Description of theoretical and experimental concepts of laboratory simulation of the characteristics of turbulence in the atmospheric surface layer. The criteria that the laboratory flow must satisfy for proper simulation are pointed out. The manner in which similitude criteria can be used to derive the dimensions of a laboratory facility required for modeling is discussed. Experiments on the generation of laboratory flows which can be used to simulate neutrally-stable atmospheric flows are described, and the characteristics of laboratory flows are compared with those of atmospheric flows. It is pointed out that the simulation of horizontally-homogeneous, thick, constant-stress layers is a necessary prerequisite to simulating more complex atmospheric flows. M.M.

A71-18592 # **On eddy-Mach wave radiation source mechanism in the jet noise problem.** J. T. C. Liu (Brown University, Providence, R.I.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 9th, New York, N.Y., Jan. 25-27, 1971, Paper 71-150.* 22 p. 36 refs. Members, $1.50; nonmembers, $2.00.

Discussion of a theoretical framework for describing the nonlinear, streamwise development of supersonically convected inviscid instability waves in a supersonic turbulent mixing layer resulting in eddy-Mach wave radiation in jet exhaust noise. It is pointed out that, from energy considerations, the streamwise rate of increase or decrease of disturbance kinetic energy flux is determined principally by the energy conversion from the mean flow through the periodic disturbance wave or eddy Reynolds stresses and energy drain through the transfer of the eddy energy to the random turbulent fluctuations, the latter being similar to but much larger than the negligible rate of viscous dissipation. The mechanism leading to the distribution of eddy strength, felt in the ambient field through radiated eddy-Mach waves, is discussed. M.M.

A71-18593 # **Finite amplitude waves from a supersonic jet.** Ian S. F. Jones (Boeing Scientific Research Laboratories, Seattle, Wash.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 9th, New York, N.Y., Jan. 25-27, 1971, Paper 71-151.* 8 p. 14 refs. Members, $1.50; nonmembers, $2.00.

The pressure fluctuations near a correctly expanded Mach number 2.5 jet have been measured in order to explain the wave pattern visible on spark shadowgraphs. Measurement of the pressure fluctuations made simultaneously with shadowgraphs showed that the density fluctuations visible on the shadowgraphs were associated with steep compressions. Results are presented which show that the waves generated near the nozzle exit are of such an amplitude that they initially steepen as they travel away from the jet, but at the exit velocity of 1810 fps, the waves depend upon the nozzle boundary layer. For a much higher velocity helium jet, the waves are generated by a much greater region extending at least 10 diameters from the nozzle. (Author)

A71-18594 • # **Noise field of coaxial interacting supersonic jet flows.** J. C. Yu and D. S. Dosanjh (Syracuse University, Syracuse, N.Y.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 9th, New York, N.Y., Jan. 25-27, 1971, Paper 71-152.* 31 p. 46 refs. Members, $1.50; nonmembers, $2.00. Grant No. NGL-33-022-082.

Experimental investigations of near and far noise fields from interacting supersonic coaxial jets at selected operating conditions have been conducted. For a comparative evaluation of the acoustic performance of coaxial jets, the noise field of a Mach 1.5 shock-free jet has also been studied. The significant modifications observed in the noise field of the coaxial interacting jets are shown to be related to some typical changes in the flow field. Furthermore, for noise abatement the acoustic performance of the coaxial interacting supersonic jets at minimum noise is found to be better than that of a supersonic shock-free jet. (Author)

A71-18596 • # **A study of the large-scale eddies of jet turbulence producing jet noise.** C. E. Wooldridge and D. C. Wooten (Stanford Research Institute, Irvine, Calif.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 9th, New York, N.Y., Jan. 25-27, 1971, Paper 71-154.* 31 p. 24 refs. Members, $1.50; nonmembers, $2.00. Contract No. NASw-1938.

This paper presents recent measurements of the turbulence structure in the initial region of a subsonic jet. Hot-wire anemometer measurements of convection velocity of the axial turbulent velocity component as functions of frequency are reported. The lower frequency components of the axial turbulent velocity are convected at a speed that is significantly slower than the local mean velocity on the inner side of the shear layer. The higher frequency components, however, are convected at a speed more nearly equal to the mean velocity and are, in fact, convected at speeds very close to the convection velocity observed for the entire frequency band. The eddies corresponding to the lower frequencies, which are closely related to the intermittency at the edges of the shear layer, apparently generate the coherent pressure field across the core region of the jet. (Author)

A71-18597 • # **Near-field characteristics of a high subsonic jet.** L. Maestrello and E. McDaid (NASA, Langley Research Center, Hampton, Va.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 9th, New York, N.Y., Jan. 25-27, 1971, Paper 71-155.* 7 p. Members, $1.50; nonmembers, $2.00.

A method has been developed to determine the distribution of acoustic energy flux through a cylindrical surface closely circumscribed about the jet. The flux is given in terms of a multiple integral involving the correlation of the pressure gradient. The numerical procedures involved have been checked using a known source. Preliminary measurements of the pressure gradient correlation have been made using a first-order pressure gradient microphone. The complete set of measurements will be used to determine the region from which sound is emanating from the jet. (Author)

A71-18603 • # **Nozzle wall boundary layers at Mach numbers 20 to 47.** Joseph H. Kemp, Jr. and F. K. Owen (NASA, Ames Research Center, Moffett Field, Calif.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 9th, New York, N.Y., Jan. 25-27, 1971, Paper 71-161.* 9 p. 31 refs. Members, $1.50; nonmembers, $2.00.

The nozzle wall boundary layer of the Ames M-50 helium tunnel has been thoroughly investigated with pitot pressure, total temperature, skin friction, wall heat transfer and hot wire measurements at 5 stations. A flow model suggested by the results is presented and discussed. Hot wire measurements indicate pronounced intermittencies at the edge of the viscous sublayer as well as the commonly observed intermittencies at the outer edge of the boundary layer. The direct skin friction measurements are higher than expected from empirical predictions and the Reynolds analogy factor, 2C sub H/C sub f, is less than unity. (Author)

A71-18616 # **Further developments in consistent unsteady supersonic aerodynamic coefficients.** Kariappa and G. C. C. Smith (Bell Aerospace Corp., Buffalo, N.Y.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 9th, New*

York, N.Y., Jan. 25-27, 1971, Paper 71-177. 15 p. 13 refs. Members, $1.50; nonmembers, $2.00. Research supported by the Bell Aerospace Corp.

A finite element method to evaluate unsteady supersonic aerodynamic coefficients to the desired level of kinematic consistency with structural stiffness and inertia properties of a lifting surface is described. The grid system and the elements on the wing planform can be the same as in the structural analysis and partial elements at wing and diaphragm edges are avoided. Downwash is expressed in terms of deformation modes, resulting in continuity and consequently yielding a more realistic pressure distribution. Application of quadratic interpolation of velocity potentials and displacements shows much improved accuracy, leading to the necessity for fewer elements. Numerical results are obtained for several AGARD wing planforms at various Mach numbers and reduced frequencies, and are compared with other methods. (Author)

A71-18620 # **Transmission and reflection of sound by a blade row.** R. K. Amiet (United Aircraft Research Laboratories, East Hartford, Conn.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 9th, New York, N.Y., Jan. 25-27, 1971, Paper 71-181.* 11 p. 12 refs. Members, $1.50; nonmembers, $2.00. Research supported by the United Aircraft Corp.

The two-dimensional problem of a plane sound wave impinging on a lattice of flat plate airfoils of infinite span in a stream of finite subsonic Mach number is treated in the limit of wavelength long compared to the plate spacing and chord. By combining a quasi-steady Prandtl-Glauert flow near the plates with a far field acoustic solution, fairly simple closed form solutions are obtained for the transmitted and reflected pressure amplitudes. A comparison with the recent numerical treatment for arbitrary wavelength of Kaji and Okazaki shows excellent agreement with their long wavelength results. (Author)

A71-18621 * # **Acoustic properties of a supersonic fan.** Arthur W. Goldstein, Frederick W. Glaser, and James W. Coats (NASA, Lewis Research Center, Cleveland, Ohio). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 9th, New York, N.Y., Jan. 25-27, 1971, Paper 71-182.* 12 p. 6 refs. Members, $1.50; nonmembers, $2.00.

An experimental study was made of the acoustics of a supersonic fan of short blade span. Measurements were obtained with and without stator blades (outlet guide vanes) to provide control of wake-chopping and other blade row interference effects. Both internal and external measurements show a relation between the internal shock-wave configuration and the intensity of the radiated sound. Substantial variations in the flow conditions at each blade of a homogeneous blade row provides an obvious source of the observed pure tone system based on multiples of the rotational speed of the shaft. This pure tone system is in evidence internally at subsonic and supersonic rotor speeds but propagates substantial amounts of power externally only at supersonic rotor speeds. (Author)

A71-18622 * # **Performance of noise suppressors for a full-scale fan for turbofan engines.** Edward J. Rice (NASA, Lewis Research Center, Cleveland, Ohio). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 9th, New York, N.Y., Jan. 25-27, 1971, Paper 71-183.* 10 p. 15 refs. Members, $1.50; nonmembers, $2.00.

Inlet and exhaust noise suppressors for a 6 ft (1.83 m) diameter fan for a high by-pass ratio turbofan engine were tested. The perforated plate on honeycomb suppressors provided a much broader band noise attenuation than was predicted. Perceived noise level attenuations due to the suppressors of 13 and 12 PNdB were obtained for simulated approach and take-off conditions respectively. The theory used for the design of the suppressors is discussed. In general, the theory predicts the frequency for peak attenuation but underpredicts the peak attenuation amplitude. For frequencies above and below peak, the observed attenuations are more than predicted. Degradations of the aerodynamic performance due to the noise suppressors were smaller than the experimental errors which were estimated to be 2%. (Author)

A71-18623 # **A method for wind tunnel investigations of sonic boom based on large models.** Y. S. Pan (Tennessee, University, Tullahoma, Tenn.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 9th, New York, N.Y., Jan. 25-27, 1971, Paper 71-184.* 16 p. 12 refs. Members, $1.50; nonmembers, $2.00. Contract No. DOT FA-70-WA-2260.

A theoretical study for a new method for wind tunnel investigations of the sonic boom problem based on large models is presented. Based on the linearized supersonic flow theory, the measured pressure signature can be related to the corresponding free flight near field pressure signature at the vicinity of the wind tunnel wall. This near field pressure signature is then related exactly to a Whitman type F function of the streamtube (quasi-circular-cylinder) which represents the wind tunnel in free flight. The propagation of the known disturbance from the near field to a distance in the mid- or the far-field is based on Whitham's hypothesis on the improvement of characteristics. Near field and three-dimensional effects are considered. Numerical examples for bodies of revolution are presented. Comparisons with results of Whitham's theory and some experiments are made. (Author)

A71-18624 # **On the experimental determination of the near-field behavior of the sonic boom, and its application to problems of N-wave focusing.** Donald J. Collins. *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 9th, New York, N.Y., Jan. 25-27, 1971, Paper 71-185.* 15 p. 21 refs. Members, $1.50; nonmembers, $2.00. Contract No. DA-31-124-ARO(D)-33.

The near-field behavior of the sonic boom generated by nonlifting, axially symmetric projectiles in a homogeneous atmosphere has been studied experimentally for Mach numbers from 1.1 to 2.6, and radial distance to length ratios from 3 to 100. The results have been compared to the first order theory by Whitham, and excellent agreement has been obtained in both the near, and mid-field regions. N-wave focusing by three-dimensional corners has been studied, and intensification factors smaller than 10 have been produced, in partial agreement with theory. Measurements are also presented for the diffraction of an N-wave over a two-dimensional plate. The results are used to compare the shape of the diffracted wave with a theoretical prediction, and to determine the pressure distribution within the zone of influence. (Author)

A71-18625 * # **Sonic boom simulation with detonable gases.** R. T. Strugielski, L. E. Fugelso, and W. J. Byrne (General American Transportation Corp., Niles, Ill.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 9th, New York, N.Y., Jan. 25-27, 1971, Paper 71-186.* 7 p. 7 refs. Members, $1.50; nonmembers, $2.00. FAA-sponsored research; Contract No. NAS 1-9252.

Far-field sonic boom pressure profiles were simulated by detonation of methane-oxygen mixtures contained in slender, shaped mylar balloons. Ideal N-waves with peak overpressures from two to five psf and durations of 30 to 75 milliseconds were synthesized using members of a family of similarly shaped balloons. The N-wave producing balloon family was obtained from evaluating and synthesizing the effects upon detonation pressure profiles due to balloon shape and gas-ignition methods. (Author)

A71-18659 # **A model for nitric oxide emission from aircraft gas turbine engines.** Ronald S. Fletcher (Northern Research and Engineering Corp., Cambridge, Mass.) and John B. Heywood (MIT,

Cambridge, Mass.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 9th, New York, N.Y., Jan. 25-27, 1971, Paper 71-123.* 15 p. 22 refs. Members, $1.50; nonmembers, $2.00. Research sponsored by the Environmental Protection Agency and FAA.

Nitric oxide concentrations in the exhaust of aircraft turbine engines are solely dependent upon the flow behavior and the chemical processes which occur within the combustion chamber and it is these features that are described by the model. The combustor flow field is assumed to comprise, in general, three zones; the primary zone in which the flow is treated as a statistical series of well-stirred reactors, the intermediate zone which follows the primary and where mixing and combustion of all unburned fuel reduces the flow field to the homogeneous state and finally the dilution zone in which additional cooling air is added to the flow. Description of the chemical processes is based upon the assumption that the hydrocarbon oxidation process is mixing controlled and an equation is derived for the nitric oxide formation rates which can be integrated through any sequence of thermodynamic states. The model has been programmed for solution by digital computer and the results presented demonstrate the influence that compressor pressure ratio, primary zone equivalance ratio and combustor residence times have upon emission characteristics. (Author)

A71-18664 Their airspace or ours - A survey of progress in bird strike prevention. A. P. De Jong (Royal Netherlands Air Force, The Hague, Netherlands). *Shell Aviation News,* no. 390, 1970, p. 2-7.

Discussion of collisions with birds, which are one of the major current flight safety problems. Royal Netherlands Air Force statistics revealed that this was the biggest single cause of accidents in the 1967 to 1969 period. Experiments have indicated that the effects of bird impact increase drastically with aircraft speed. Doubling the bird mass increases the impact force by a factor of only 1.5, but when speed is doubled the force rises fourfold. The use of bird distress calls, the eviction of birds by flying birds of prey, such as falcons and goshawks, and the influence of migration are considered. Many bird species appear to migrate along fixed airways, hence bird warnings can be included in preflight briefings to pilots. Another method of predicting a strike hazard involves the application of long range radar. F.R.L.

A71-18665 The Link 747 simulator. Ed Mack Miller (United Air Lines, Inc., Chicago, Ill.). *Shell Aviation News,* no. 390, 1970, p. 8-11.

Description and evaluation of a highly sophisticated ground trainer. The Link 747 simulator has a six-degrees-of-motion system which is so good that, with the loss of an engine on simulated takeoff, it is possible to tell which engine stopped from the sensory clues available. The captain's, first officer's, and engineer's positions are faithful to the cockpit of the aircraft itself. The Malfunction Insertion and Display Unit (MIDU) which can simulate many thousands of things that can be practiced is described. Attention is given to the VAMP (Variable Anamorphic Motion Picture) system. It bridges the gap between the transition from instrument flying to visual flying. The simulator makes possible quick, economical, and safe instruction. F.R.L.

A71-18701 # Lifting surface in an unsteady flow near a screen (Nesushchaia poverkhnost' v nestatsionarnom potoke vblizi ekrana). B. N. Belousov, A. N. Lukashenko, and A. N. Panchenkov. *Samoletostroenie i Tekhnika Vozdushnogo Flota,* no. 18, 1970, p. 3-11. 11 refs. In Russian.

Application of the integral operator method in a potential acceleration space to an analysis of the unsteady motion of a wing with finite span in an ideal incompressible liquid near a solid surface. A two-dimensional integral equation is obtained to determine this motion. The Prandtl problem of a large aspect wing near a screen is solved by reducing this equation into two one-dimensional equations. A procedure for solving these equations is set forth. Also derived and solved are formulas for the lift factor of a large aspect wing near a screen. The usefulness of these formulas in practical calculations is indicated. V.Z.

A71-18705 # Experimental study of secondary losses in a plane compressor grid with low aspect vanes (Eksperimental'noe issledovanie vtorichnykh poter' v ploskoi kompressornoi reshetke s lopatkami malogo udlineniia). A. D. Griga, V. V. Omel'chenko, and I. L. Sholomov. *Samoletostroenie i Tekhnika Vozdushnogo Flota,* no. 18, 1970, p. 31-34. 11 refs. In Russian.

Tests are carried out to determine the effects of various individual design features on flow characteristics and on the performance of compressor grids with low-aspect-ratio vanes. The effects of the presence of longitudinal fins, protruding elements in the grid geometry and smoothed junctions between bulging portions of grid profiles and the encasing walls on the energy losses in a compressor grid are discussed. It is shown that secondary energy losses in a plane compressor grid depend strongly on the interaction between the boundary layer at the duct wall and the boundary layer on the convex elements of the grid profile geometry. V.Z.

A71-18706 # Use of short-lived isotopes for heating a working body (O primenenii kratkozhivushchikh izotopov dlia nagreva rabochego tela). V. V. Balyberdin. *Samoletostroenie i Tekhnika Vozdushnogo Flota,* no. 18, 1970, p. 35-37. In Russian.

Suggestion of Namnas (1955) to use the Al 27 isotope for heating a working body in the heat exchangers of jet engines is evaluated. An equation is derived for the radioactivity of an Al 27 specimen obtained by irradiation of Al in a thermal neutron reactor. This variable can be determined as a function of the neutron flux, the neutron absorption cross section and the density of the specimen by using this equation. It is found that the energy released by radioactive beta decay is sufficient only for a 100 sec flight of a 30-ton rocket when an Al 27 specimen having a mass of 3,640 tons is used for propulsion. V.Z.

A71-18714 # Approximation of aircraft surfaces by second-order surfaces (Approksimatsiia samoletnykh poverkhnostei poverkhnostiami vtorogo poriadka). A. D. Neshumaev and G. A. Linkin. *Samoletostroenie i Tekhnika Vozdushnogo Flota,* no. 18, 1970, p. 118-120. In Russian.

A procedure is set forth for the approximate determination of surfaces of complex geometries, such as those of aircraft components, given in the form of discrete points. Essential in this procedure is the approximation of the unknowns by second-order surfaces obtained in general form. This method is believed to be more efficient than other methods in that it not only approximates a priori discretely given smooth surfaces but also eliminates rough points on not ideally smooth surfaces. V.Z

A71-18715 # Computer optimization for conducting a small-scale multinomenclature production process (Optimizatsiia vedeniia melkoseriinogo mnogonomenklaturnogo proizvodstva posredstvom ETsVM). A. L. Bashta, A. I. Babushkin, and L. P. Vasil'chenko. *Samoletostroenie i Tekhnika Vozdushnogo Flota,* no. 18, 1970, p. 121-129. In Russian.

A theoretical basis for a mathematical model of a small-scale versatile aircraft component production process is discussed. A formula is derived for determining an optimal operational cycle in the production of structural and machine parts of various designs and specifications on an assembly line. A computer production optimization algorithm is also developed. The algorithm and a computer program were used to set up a production process and assembly lines at an aircraft plant. Charts are also given to illustrate the optimization of a small-scale multiproduct aircraft-part manufacturing process. V.Z.

STAR ENTRIES

N71-14501*# National Aeronautics and Space Administration Flight Research Center, Edwards, Calif.
FIN LOADS AND CONTROL-SURFACE HINGE MOMENTS MEASURED IN FULL-SCALE WIND-TUNNEL TESTS ON THE X-24A FLIGHT VEHICLE
Ming H. Tang and V. Michael De Angelis Washington Nov. 1969 36 p refs
(NASA-TM-X-1922; H-580) Avail: NTIS CSCL 01A

Tests were conducted on the full-scale X-24A lifting body in a 40- by 80-foot wind tunnel. One purpose of the tests was to measure aerodynamic loads on the stabilizing fins and hinge moments on all the control surfaces. The tests were conducted at dynamic pressures of 60, 80, and 100 lb/sq ft. The effects of variations in rudder deflection, flap deflection, and angles of attack and sideslip were studied. Also, limited tests were performed with a simulated ablated coating over most of the vehicle to assess the effects of the ablated surface on the aerodynamic characteristics. Detailed results of the wind-tunnel tests are given in the form of load coefficients and hinge-moment coefficients. The results are compared with data from tests performed in other wind tunnels on small-scale models. Author

N71-14526*# National Aeronautics and Space Administration. Flight Research Center, Edwards, Calif.
OPERATIONAL EXPERIENCES AND CHARACTERISTICS OF THE M2-F2 LIFTING BODY FLIGHT CONTROL SYSTEM
Weneth D. Painter and Erwin M. Kock Washington Jun. 1969 31 p refs
(NASA-TM-X-1809) Avail: NTIS CSCL 01A

Flights of the M2-F2 lifting body demonstrated that the manual control system and the stability augmentation system met the operational flight control requirements for the test vehicle. The regions of pilot-induced oscillation predicted from ground simulation were encountered in flight. The pilots considered the control system to be adequate for the M2-F2 flight envelope flown. Limit-cycle data obtained during ground tests agreed with flight results. Author

N71-14527*# National Aeronautics and Space Administration. Flight Research Center, Edwards, Calif.
INTERIM RESULTS OF THE LIFTING-BODY FLIGHT-TEST PROGRAM
Garrison P. Layton, Jr. Washington Jul. 1969 26 p refs Presented at AIAA Entry Vehicle Systems and Technol. Meeting, Hampton, Va., 3-5 Dec. 1968
(NASA-TM-X-1827) Avail: NTIS CSCL 01A

The significant results of the joint NASA/U.S. Air Force lifting-body flight-test program are presented in general terms, based on unpowered M2-F2 and HL-10 flights. The lifting-body flight-test program demonstrated that lifting reentry vehicles can be maneuvered to an unpowered landing from initial conditions representing the entry of the terminal area for a reentry vehicle. Wind-tunnel predictions of the aerodynamic characteristics of these shapes up to a Mach number of approximately 0.7 were in fair agreement with flight data, with some notable exceptions. The predictions tended to be low on stability and control effectiveness and did not predict trim to the accuracy desired, nor the severity of separated flow over the aft part of the HL-10 vehicle. The flight simulators and pilot-in-the-loop theoretical analysis accurately predicted the handling characteristics, but conventional handling-qualities criteria do not necessarily apply to lifting reentry vehicles. Author

N71-14537# Douglas Aircraft Co., Inc., Long Beach, Calif.
FORMAT-FORTRAN MATRIX ABSTRACTION TECHNIQUE. VOLUME 7, SUPPLEMENT 1: DESCRIPTION OF DIGITAL COMPUTER PROGRAM, PHASE 3, EXTENDED Final Report, 1 Jul. 1968 - 30 Apr. 1970
J. A. Frank Wright-Patterson AFB, Ohio AFFDL Aug. 1970 39 p refs
(Contract F33615-68-C-1633)
(AD-713840; DAC-33569-Vol-7-Suppl-1; AFFDL-TR-66-207-Vol-7-Suppl-1) Avail: NTIS CSCL 20/11

The format System has been updated by the incorporation of additional basic capability and the refinement of existing capability. A simpler mode of updating case data and extended force method matrix generation capability has been incorporated in Phase I of the system. A refined "Structure Cutter' module, capabilities for matrix partitioning and instruction looping, and an additional eigenvalue/eigenvector extraction module have been incorporated in Phase II. Finally the Limitations which existed in the matrix plotting capability in Phase III have been eliminated. Programming documentation for the extended capability of Phase III of the format System is presented in this report.

Author (TAB)

N71-14538# Douglas Aircraft Co., Inc., Long Beach, Calif.
FORMAT-FORTRAN MATRIX ABSTRACTION TECHNIQUE. VOLUME 5, SUPPLEMENT 1: ENGINEERING USER AND TECHNICAL REPORT EXTENDED Final Report, 1 Jul. 1968 - 30 Apr. 1970
J. Pickard Wright-Patterson AFB, Ohio AFFDL Aug. 1970 75 p refs
(Contract F33615-68-C-1633)
(AD-713727; DAC-33569-Vol-5-Suppl-1-AFFDL-TR-66-207-Vol-5-Suppl-1) Avail: NTIS CSCL 20/11

The format System has been updated by the incorporation of additional basic capability and the refinement of existing capability. A simpler mode of updating case data and extended force method matrix generation capability has been incorporated in Phase I of the system. A refined 'Structure Cutter- module, capabilities for matrix partitioning and instruction looping, and an additional eigenvalue/eigenvector extraction module have been incorporated in Phase II. Finally the limitations which existed in the matrix plotting capability in Phase III have been eliminated. Engineering user and technical information is presented in this report. Included are recommendations of improvements in implementation and utilization procedures for various computer systems.

Author (TAB)

N71-14555# Army Command and General Staff Coll., Fort Leavenworth, Kans.
SOVIET CIVIL AIR TRANSPORT: AN APPRAISAL
Gilbert E. Jones May 1970 120 p refs
(AD-713415) Avail: NTIS CSCL 1/2

The purpose of the study is to provide a comprehensive description of civil air transport in the USSR and to offer an appraisal of its contemporary status. Although a brief historical sketch of Soviet civil aviation has been included, the study concentrates on the 1960-1970 period. The organizational structure, operational procedures, the commercial aircraft inventory, and the prospects for future development are the major features of Soviet civil air transport that are examined. Author (TAB)

N71-14558# Princeton Univ., N.J. Dept. of Aerospace and Mechanical Sciences.

FLIGHT EVALUATION OF THE EFFECTS OF SHORT PERIOD FREQUENCY AND NORMAL ACCELERATION RESPONSE IN CARRIER APPROACH Final Report, Apr. –Jun. 1969

Edward Seckel and George E. Miller Nov. 1969 37 p refs
(Contract Nonr-1858(50); Grant NSF GP-579)
(AD-713125) Avail: NTIS CSCL 1/2

The results of an aircraft flying qualities research program are presented. Navy test pilot evaluations in the form of pilot ratings and specific comments of several longitudinal handling characteristics were obtained for a simulated carrier landing task. The investigation made use of a variable stability aircraft which accurately simulated the longitudinal short period response characteristics and the effects of atmospheric turbulence. The flying qualities associated with variations in short period frequency, lift curve slope, and the use of direct lift control are presented. The data are compared with similar data obtained from flight and ground simulator tests. All configurations tested were found to be acceptable for the daylight visual carrier approach task, and only minor differences in the flying qualities of the configurations were evident. Author (TAB)

N71-14559# Army Natick Labs., Mass.

THE INTERNAL AND EXTERNAL FLOW FIELD ASSOCIATED WITH PARACHUTES DURING INFLATION

Gregory C. De Santis 1970 15 p refs
(AD-713520) Avail: NTIS CSCL 1/3

A hot-wire anemometer was used to obtain data on the flow field associated with an inflating parachute. Seven models simulating various stages of inflation of the C-9 parachute were fabricated and tested in a specially constructed test section where the temperature could be held uniform. Using this method, it was possible to accurately measure the internal and external flow surrounding the canopy. Some possible applications of the data to full-scale parachute systems are presented. Author (TAB)

N71-14567# National Aviation Facilities Experimental Center, Atlantic City, N.J.

SYSTEM SHAKEDOWN TESTS (C30/60N) NAS EN ROUTE STAGE A MODEL 1, FUNCTIONAL PACKAGE B Final Report, Mar. – Oct. 1969

Joseph Levy et al Dec. 1970 147 p refs Sponsored by FAA
(FAA-NA-70-31) Avail: NTIS

System shakedown tests were conducted as needed to identify and aid in the resolution of hardware and software problems in achieving stable, acceptable, and reliable operation of the NAS En Route Stage A Model 1 System. Controller, engineering, and maintenance personnel were integrated into the system for identifying and resolving problems in the man/machine interface area. Four test phases, identified in total as C30/60 testing, included investigation of (1) computer program functions and operational test procedures, (2) baseline verification of modified operational computer programs, (3) system failure and recovery, and (4) procedures for radar control to allow either partial or full system testing while simultaneously controlling live traffic without derogating safety of the operation. Author

N71-14584# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

EXTERNAL LOADS AND THE STRENGTH OF FLIGHT VEHICLES

A. I. Gudkov et al 3 Sep. 1970 120 p refs Transl. into ENGLISH from the Russian
(AD-713461; FTD-MT-24-64-70) Avail: NTIS CSCL 1/3

Contents: Loads during landing and ground movement; Action of dynamic loads on the construction; Application of computers for investigation of dynamic loading of constructions. TAB

N71-14585# Army Electronics Command, Fort Monmouth, N.J.

A STUDY OF THE DYNAMIC MOTIONS OF HINGELESS ROTORED HELICOPTERS

Norman K. Shupe Aug. 1970 268 p refs
(AD-713402; ECOM-3323) Avail: NTIS CSCL 1/3

The hingeless rotor is modeled as a system of thin cantilevered members, infinitely stiff in torsional and chordwise bending, executing pure elastic flapwise bending. It is shown that to model the rotor from hover thru high speed flight, the motions of a blade must be represented by its first two natural modes of flapwise bending. For this blade model, it is also shown that the hub moment developed is linearly related to the tip path plane tilt in hover but that the relationship becomes markedly nonlinear with increasing forward speed. Consideration is also given to the effects of a non-uniformly distributed induced velocity field.The characteristics of the Lockheed gyro stabilization system are compared to those of the Bell gyro system and a conventional electronic stabilization system utilizing body mounted sensors. Author (TAB)

N71-14591*# McDonnell-Douglas Co., Long Beach, Calif.

INVESTIGATION OF DC-8 NACELLE MODIFICATIONS TO REDUCE FAN-COMPRESSOR NOISE IN AIRPORT COMMUNITIES. PART 6: PSYCHOACOUSTIC EVALUATION Technical Report, May 1967 – Mar. 1970

Lawrence E. Langdon, Richard F. Gabriel, and Alan H. Marsh Washington NASA Dec. 1970 44 p refs
(Contract NAS1-7130)
(NASA-CR-1710) Avail: NTIS CSCL 01B

Nacelle modifications intended to reduce fan-compressor noise emitted from DC-8-50/61 airplanes were fabricated and flight tested. Subjective reaction to the flyover noise of these nacelle modifications was assessed by asking 41 college students to judge the acceptability of the sound of existing and modified aircraft as reproduced in an anechoic chamber. The method of constant stimulus differences was used to assess pairs of stimuli. Each pair consisted of one recording from each aircraft. Sounds recorded outdoors and indoors were included. Operational conditions were tested that represented takeoff, reduced-climb-gradient, and landing-approach thrusts at nominal heights ranging from 500 to 2500 feet. The most important findings were: (1) Improvements were noted for all heights and thrusts investigated, (2) For the landing-approach thrust condition, the judged improvement in the noise due to the installation of modified nacelles ranged from 11 to 14 EPNdB over the range of heights investigated, and (3) The effective-perceived-noise-level noise-rating scale adequately assessed the improvement in acceptability. Author

N71-14592*# McDonnell-Douglas Co., Long Beach, Calif.

INVESTIGATION OF DC-8 NACELLE MODIFICATIONS TO REDUCE FAN-COMPRESSOR NOISE IN AIRPORT COMMUNITIES. PART 5: ECONOMIC IMPLICATIONS OF RETROFIT Technical Report, May 1967 – Oct. 1969

H. D. Whallon, Ellis J. Gabbay, G. B. Ferry, Jr., and N. L. Cleveland Washington NASA Dec. 1970 57 p refs
(Contract NAS1-7130)
(NASA-CR-1709) Avail: NTIS CSCL 01A

The economic effects of retrofitting the airplanes with modified nacelles were studied for an assumed fleet of DC-8-50/61 airplanes in passenger service. These airplanes are equipped with nacelles having short fan-exhaust ducts. Estimates were made of the initial costs of retrofitting the airplanes with modified nacelles, and of the effects of the modifications on direct operating cost, profit, taxes, airplane investment, and return on airplane investment. In addition, estimated effects of the modifications on basic airplane performance characteristics were considered. These calculated performance characteristics (and the calculations of direct operating cost) were based on flight test results obtained in the third phase of the program. An economic life of 5 years was assumed for the retrofit kits on series 50 airplanes and 5 and 10 years on model 61

airplanes. The study indicated that direct operating cost would be increased between 4 and 5 percent, assuming a 5-year amortization of the retrofit cost and modification of all short-duct DC-8 airplanes. Doubling the amortization period would approximately halve the increase in direct operating cost. The increase in direct operating cost would be due almost entirely to amortization of the costs of modification. On the assumption that operating revenues would be the same for the existing and treated airplanes, calculations indicated that profit after taxes and federal income taxes would be reduced about 10 percent for 5 years, the investment book value of airplane inventory would be increased 18.5 percent, and the discounted cash flow rate of return on airplane investment would be reduced about 8 percentage points, about a one-quarter reduction from the existing level. Author

N71-14593*# McDonnell-Douglas Co., Long Beach, Calif.
INVESTIGATION OF DC-8 NACELLE MODIFICATIONS TO REDUCE FAN-COMPRESSOR NOISE IN AIRPORT COMMUNITIES. PART 3: STATIC TESTS OF NOISE SUPPRESSOR CONFIGURATIONS, MAY 1967 – OCTOBER 1969
J. Kenneth Manhart, D. A. Campbell, C. A. Henry, and E. M. Lowder Washington NASA Dec. 1970 173 p refs
(Contract NAS1-7130)
(NASA-CR-1707) Avail: NTIS CSCL 21E

Four acoustically treated inlet-duct configurations, a simulated variable-area primary nozzle, and one set of acoustically treated fan-exhaust ducts were fabricated, tested, and evaluated. The test articles were installed on a JT3D turbofan engine mounted on an engine test stand. Far-field sound pressure levels (at a distance of 150 ft from the engine) and engine-performance data were obtained to evaluate the performance of the test configurations. The objective of the tests was to reduce the perceived noise level during the landing approach of DC-8-50/61 airplanes. The goal of the program was a 7 to 10 PNdB reduction in perceived noise level under the landing-approach path with no increase in noise under the takeoff flight path. The reduction in perceived noisiness was to be obtained through significant reduction in the discrete-frequency tones radiated from the inlet and fan-exhaust ducts. As a result of acoustical and engine performance evaluations, a treated-nacelle configuration, consisting of a treated one-ring inlet and treated 48-inch-long fan-exhaust ducts, was selected for flight testing. The selected configuration was estimated to be able to meet the 7 to 10 PNdB noise-reduction design goal. Author

N71-14594*# McDonnell-Douglas Co., Long Beach, Calif.
INVESTIGATION OF DC-8 NACELLE MODIFICATIONS TO REDUCE FAN-COMPRESSOR NOISE IN AIRPORT COMMUNITIES. PART 2: DESIGN STUDIES AND DUCT-LINING INVESTIGATIONS, MAY 1967 – OCTOBER 1969
Alan H. Marsh, R. L. Frasca, D. K. Gordon, C. A. Henry, G. L. Laurie, et al Washington NASA Dec. 1970 198 p refs
(Contract NAS1-7130)
(NASA-CR-1706) Avail: NTIS CSCL 21E

Designs for two fan-exhaust ducts and eight inlet ducts applicable to the JT3D turbofan engines on DC-8-50/61 airplanes were studied. The designs were evaluated in terms of (1) their estimated ability to produce a 7 to 10 PNdB reduction in perceived noise level during landing approach and (2) their estimated impact on direct operating costs. Two inlet-duct designs and one fan-exhause-duct design were selected for ground static testing. One of the inlet designs incorporated acoustically absorptive linings on the walls of a revised inlet duct, two concentric ring vanes, and a lengthened centerbody. The other design had treatment on the walls of a lengthened inlet duct, one concentric ring vane, and an enlarged lightbulb-shaped centerbody. The fan-exhaust duct design provided acoustical linings in an exhaust duct 24 inches longer than the existing ducts, thus requiring a new fan thrust reverser but preserving the existing primary thrust reverser. Acoustical duct-lining studies consisted of: flow resistance; acoustic absorption and impedance; duct transmission-loss; and sonic-fatigue tests. Structural duct-lining studies consisted of: determination of structural design criteria for duct linings; structural tests of bonded honeycomb sandwich structures; and development of fabrication procedures for duct linings. The result of these acoustical and structural studies was the selection of the materials and fabrication processes used in contructing the test articles for the ground static tests. Author

N71-14595*# McDonnell-Douglas Co., Long Beach, Calif.
INVESTIGATION OF DC-8 NACELLE MODIFICATIONS TO REDUCE FAN-COMPRESSOR NOISE IN AIRPORT COMMUNITIES. PART 1: SUMMARY OF PROGRAM RESULTS Technical Report, May 1967 – Mar. 1970
Robert E. Pendley and Alan H. Marsh Washington NASA Dec. 1970 38 p refs
(Contract NAS1-7130)
(NASA-CR-1705) Avail: NTIS CSCL 01B

An investigation was conducted of methods to reduce fan-compressor noise from the JT3D-3B engines of DC-8 aircraft equipped with short duct nacelles. The purpose of the investigation was to define modifications that could be applied to the nacelles of operational aircraft to reduce the perceived noise level by 7 to 10 PNdB under the landing approach path without adverse effects on takeoff noise. The program included laboratory investigations, full-scale ground tests, and flight tests. Author

N71-14596*# Boeing Co., Seattle, Wash.
STUDY AND DEVELOPMENT OF TURBOFAN NACELLE MODIFICATIONS TO MINIMIZE FAN-COMPRESSOR NOISE RADIATION. VOLUME 1: PROGRAM SUMMARY, 1 MAY 1967 – 1 NOVEMBER 1969
Washington NASA Jan. 1971 38 p refs
(Contract NAS1-7129)
(NASA-CR-1711) Avail: NTIS CSCL 21E

The results of a flight evaluation of an acoustically treated nacelle installed on the JT3D turbofan engines on a Boeing 707-320C airplane and the economic impact of this installation are discussed. The program objective was a PNL reduction of 15 PNdB to landing approach noise which was accomplished by installing two acoustically treated rings in the engine inlet and by acoustically treating an extended length fan duct configuration. The acoustic treatment consisted of a polyimide-fiberglass sandwich material. A detail description of the nacelle is presented and a summary of the acoustic and performance results of the flight evaluation are presented. In addition, the structural-mechanical aspects and the impact on operational factors are reviewed. Both operating costs and impact on airline operations based on retrofit of these nacelles are reviewed in the economic analysis. Author

N71-14600*# Serendipity, Inc., Palo Alto, Calif.
IMPROVED DISPLAY SUPPORT FOR FLIGHT MANAGEMENT DURING LOW VISIBILITY APPROACH AND LANDING. A SIMULATOR EVALUATION OF AN ILS-INDEPENDENT RUNWAY PERSPECTIVE DISPLAY Final Report
Walter B. Gartner and Kenneth M. Baldwin Nov. 1970 97 p refs
(Contract NAS2-5851)
(NASA-CR-73495; TR386-70-01) Avail: NTIS CSCL 01B

A preliminary evaluation of an ILS-independent, pictorial runway perspective display concept was conducted. The improvement which might be realized in the accuracy of flight management task performance was determined. Six senior airline pilots flew a total of 180 simulated approach and landing sequences using three different displays as the basis for approach assessment tasks. The three alternate display concepts were designed to provide increasing levels of directness in representing the flight situation parameters relevant to the flight management task. Author

N71-14603# Barkley and Dexter Labs., Inc., Fitchburg, Mass.
RESEARCH DIRECTED TOWARD THE EXPERIMENTAL INVESTIGATION OF METHODS OF ANALYZING SO2/SO3 RATIOS IN JET EXHAUSTS Final Report, 15 Aug. 1966 - 14 Aug. 1969
Lawrence R. Day, Edwin C. Dunton, Raymond B. Wilson, and Michael Zinchuk 6 May 1970 35 p
(Contract AF 19(628)-6137)
(AD-713222; AFCRL-70-0279) Avail: NTIS CSCL 7/4

Research was directed towards the analysis of SO2/SO3 ratios in jet exhausts at temperatures of 600C and Mach I gas streams. Spectral absorbance measuring techniques in the ultra violet region of the spectrum appeared to offer the best method of measurement. Equipment was designed and developed incorporating these techniques. Other aspects of jet exhausts were also investigated including contrail scattering and ionization effects. Equipment was also developed for the measurement of infrared radiation from a jet engine. Author (TAB)

N71-14604# Army Aeronautical Research Lab., Moffett Field, Calif.
MASS FLOW, VELOCITY AND IN-FLIGHT THRUST MEASUREMENTS BY ION DEFLECTION
C. Rande Vause and Robert S. Rudland 1970 15 p refs
(AD-713587) Avail: NTIS CSCL 1/4

An investigation was made of the use of gaseous (ion) discharge sensors to achieve adequate measure of aircraft velocity and installed thrust. Author (TAB)

N71-14605*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
WIND-TUNNEL INVESTIGATION OF A JET TRANSPORT AIRPLANE CONFIGURATION WITH AN EXTERNAL-FLOW JET FLAP AND INBOARD POD-MOUNTED ENGINES
Delma C. Freeman, Jr., Lysle P. Parlett, and Robert L. Henderson Washington Dec. 1970 122 p refs
(NASA-TN-D-7004; L-7403) Avail: NTIS CSCL 01A

A wind tunnel investigation was conducted to determine the aerodynamic, stability, and control characteristics of a jet transport airplane configuration with an external-flow jet flap and four pod-mounted engines. Major emphasis of the investigation was placed on determining the effectiveness of close-inboard mounting of the engines as a means of reducing the large engine-out moments inherent in an external-flow jet-flap system and of evaluating the use of asymmetric blowing on drooped ailerons or the use of differential flap deflection as a means of providing trim to offset the engine-out moments. Author

N71-14612# National Research Council of Canada, Ottawa (Ontario).
A STUDY OF PRESSURE DISTRIBUTIONS CALCULATED WITH THE SELLS METHOD ON A SERIES OF QUASI-ELLIPTICAL SYMMETRICAL AIRFOILS IN SUBCRITICAL FLOW
J. J Kacprzynski Jun. 1970 39 p refs
(NRC-11693; LR-533) Avail: NTIS

Pressure distributions on seven quasi-elliptical profiles were calculated with Sells method, using different mesh sizes and smoothing parameters. The results are compared with Boerstoel's results obtained with Nieuwland's method for design flow conditions. Some results for off-design conditions are given. Proper use of Sells method is described and plots of the pressure distributions are included. Author

N71-14613*# Aerophysics Research Corp., Bellevue, Wash.
APPLICATION OF MULTIVARIABLE SEARCH TECHNIQUES TO THE DESIGN OF LOW SONIC BOOM OVERPRESSURE BODY SHAPES
D. S. Hague and R. T. Jones Nov. 1970 116 p refs
(Contract NAS2-4880)
(NASA-CR-73496) Avail: NTIS CSCL 01A

The Whitham - Lighthill method for describing the flow about a supersonic body of revolution is outlined and a computational method for locating shocks within the field is described. An outline of multivariable search procedures is presented in some detail. The method in which a series of body shaping problems are reduced to the multivariable optimization form is described. Several alternate multivariable optimization formats are employed including single and multiple-arc formations. Each formulation is exercised, and a series of low boom shapes are defined. Several of the multiple-arc solutions arrive at sonic boom overpressure values well below previously reported single-arc variational solutions. The practicality of these lower boom shapes is discussed; it is recommended that some of the more promising low boomshapes be tested with the objective of confirming their predicted characteristics. Author

N71-14614*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
EFFECTS OF A RETRONOZZLE LOCATED AT THE APEX OF A 140 DEG BLUNT CONE AT MACH NUMBERS OF 3.00, 4.50, AND 6.00
Robert J. McGhee Washington Jan. 1971 40 p refs
(NASA-TN-D-6002; L-7312) Avail: NTIS CSCL 20D

Several distinct types of flow occurred on the cone, including two unsteady-flow regimes and two steady-flow regimes. Generally, the unsteady flows were restricted to low values of nozzle thrust and were observed at all angles of attack. The two steady-flow regimes occurred with increasing nozzle thrust; at the highest test values of nozzle thrust, the condition of no shear-layer reattachment on the cone was approximate. For the steady-flow regimes, the locations of the jet shock, flow interface, and bow shock together with the separation and reattachment pressures were all primarily functions of the nozzle-thrust coefficient. Because of the extensive flow separation and accompanying low pressure on the cone surface, only at the highest thrust values was the total drag (integrated-pressure drag coefficient plus nozzle-thrust coefficient) greater than the jet-off value of integrated-pressure drag coefficient. This result was obtained at all three test Mach numbers. Author

N71-14617# Air Force Systems Command, Wright-Patterson AFB, Ohio. Aero Propulsion Lab.
PARAMETERS AFFECTING THE MEASUREMENT OF AERO ENGINE EXHAUST SMOKE: A STATISTICAL ANALYSIS OF TEST DATA Technical Report, Sep. 1969 Feb. 1970
Donald L. Champagne Aug. 1970 63 p refs
(AD-713612; AFAPL-TR-70-23) Avail: NTIS CSCL 21/5

The report describes a computerized statistical analysis of test data from engine smoke measurements. The analysis indicated that test data can be used to arrive at statistically meaningful conclusions about four measuring system parameters. Author (TAB)

N71-14618# Research Inst. of National Defence, Stockholm (Sweden).
RAM ENGINE WITH INTEGRATED STARTING STAGE RRX1 (KRP4). THEORETICAL CALCULATION OF CHANGES IN DIMENSIONS OF THE SOLID FUEL CHARGE WITH HARDENING AND COOLING IN STEEL AND DURESTOS CASING RESPECTIVELY [RAMMOTOR MED INTEGRERAT STARTSTEG RRX1 (KRP4). TEORETISK BERAEKNING AV DIMENSIONS-AENDRINGAR HOS KRUTLADDNINGEN VID HAERDNING OCH AVKYLNING I STALRESPEKTIVE DURESTOSHYLSA]
Bert Andersson and Arnold Magnusson Aug. 1969 9 p In SWEDISH
(FOA-2-C-2337-46) Avail: NTIS

In the manufacture of solid fuel charges for RRX1 it has been difficult to withdraw the core after the completion of hardening. Analysis of the changes in the shape of the charge by means of the finite element program shows that the reason could be the low form stability of the mold/engine insulation made for Durestos. The measures taken have eliminated the problem. Author

N71-14619# Research Inst. of National Defence, Stockholm (Sweden).
RAM ENGINES WITH INTEGRATED STARTING STAGE RRX5 (KRP5). PROPOSAL FOR DESIGN AND CALCULATION OF PERFORMANCE OF A SOLID FUEL ROCKET MOTOR [RAMMOTOR MED INTEGRERAT STARTSTEG RRX5 (KRP5). FOERSLAG TILL UTFORMNING OCH BERAEKNING AV PRESTANDA FOER KRUTRAKETMOTORN]
Bert Andersson and Arnold Magnusson Jul. 1969 13 p In SWEDISH
(FOA-2-C-2331-46) Avail: NTIS

Theoretical calculations were carried out for a tube and rod charge for the RRX5. An aluminium-enriched polybutadiene charge is proposed which gives a total thrust of 36,000 Ns. The corresponding value for the given nc-based propellent is 29,500 Ns maximum. Results are also given from experiments on a rocket igniter which is combined with the pyrotechnic for the ram engine phase. The results are favorable and an igniter of this type is suggested for preliminary trial in a full scale test. Author

N71-14623# Air Weather Service, Scott AFB, Ill.
A SUMMARY OF AIRLINE WEATHER-RADAR OPERATIONAL POLICIES AND PROCEDURES
Paul Kadlec Sep. 1970 21 p refs
(AD-713636; AWS-TR-238) Avail: NTIS CSCL 4/2

The report discusses and summarizes the Weather-Radar operational policies and procedures of eleven US commercial airlines. Author (TAB)

N71-14629# State Committee for Civilian Construction and Architecture, Moscow (USSR).
THE USE OF DIRIGIBLES IN CONSTRUCTION [DIRIZHABLI NA STROYKAKH]
T. I. Alekseyeva and N. A. Brusentsev 1968 56 p refs In RUSSIAN
Avail: NTIS

The prospective application of dirigibles in the national economy is discussed, with special emphasis on their use in construction. The engineering and operational aspects of dirigibles are considered and the technical and economic characteristics of dirigible development, both domestic and foreign, are investigated. Transl. by R.B.

N71-14634*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
DYNAMIC STABILITY DERIVATIVES OF A TWIN-JET FIGHTER MODEL FOR ANGLES OF ATTACK FROM −10 DEG TO 110 DEG
Sue B. Grafton and Charles E. Libbey Washington Jan. 1971 38 p refs
(NASA-TN-D-6091; L-7370) Avail: NTIS CSCL 01A

A low-speed investigation was conducted to determine the dynamic stability derivatives in pitch, roll and yaw over an angle-of-attack range of −10 deg to 110 deg for a twin-jet swept-wing fighter model. Several frequencies and amplitudes were investigated to determine the effects of these variables on the stability derivatives. The effect of the vertical and horizontal tail, and horizontal-tail incidence on the derivatives were also evaluated. The results indicate that the model exhibited stable values of damping in pitch over the entire angle-of-attack range, but marked reductions of damping in roll were measured at the stall, and unstable values of damping in yaw were present for the very high angles of attack associated with flat spins. Either removal of the horizontal or vertical tail or full deflection of the horizontal tail eliminated the unstable characteristics of the damping-in-yaw derivatives. Author

N71-14635*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
INVESTIGATION OF ENGINE-EXHAUST-AIRFRAME INTERFERENCE ON A CRUISE VEHICLE AT MACH 6
James M. Cubbage and Frank S. Kirkham Washington Jan. 1971 64 p refs
(NASA-TN-D-6060; L-6488) Avail: NTIS CSCL 01A

Results from an investigation of the effects of underexpanded engine exhaust flow on the aerodynamic performance and stability of a cruise airplane at Mach 6 are presented. The influence of wing reflex angle and nozzle geometry on exhaust flow interference effects was investigated on a flat-plate model. The experiments were conducted at a free-stream Reynolds number of 17.05 × 1,000,000 based on the length of the airplane model over a model angle-of-attack range of 0 deg to 10 deg and at nozzle static-pressure ratios from 1 to approximately 4. Author

N71-14638*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
AERODYNAMIC CHARACTERISTICS OF A LARGE-SCALE MODEL WITH A LIFT FAN MOUNTED IN A 5 PERCENT THICK TRIANGULAR WING, INCLUDING THE EFFECTS OF BLC ON THE LIFT FAN INLET
Brent K. Hodder, Jerry V. Kirk, and Leo P. Hall Washington Dec. 1970 56 p refs Prepared in cooperation with Army Air Mobility R and D Lab.
(NASA-TN-D-7031; A-2822) Avail: NTIS CSCL 01A

The low-speed aerodynamics of a large-scale triangular wing model, with a reduced thickness, tip-turbine driven lift fan in each wing were investigated in a 40- by 80-foot wind tunnel. The model had a 5-percent-thick wing typical of wings designed for supersonic performance. A thin lift fan for the investigation was obtained by modification of a conventional fan. The modification included removing the discharge stator and reducing the fan inlet length and radius. To control airflow separation resulting from small inlet radii, blowing boundary-layer control was applied through a nozzle in the inlet. Performance of the modified fan along with aerodynamic characteristics of the total configuration is presented. The static thrust performance of the conventional fan (requiring a 10-percent wing) was equalled by the reduced thickness of the modified fan. Author

N71-14649# Army Foreign Science and Technology Center, Washington, D.C.
FLYING WEIGHT OF AN AIRCRAFT GENERATOR [POLETHYY VES SAMOLETNOGO GENERATORA]
D. I. Zaslavskiy 3 Jun. 1970 11 p refs Transl. into ENGLISH from Elektrotekhnika (USSR), v. 39, no. 4, 1968 p 4–6
(AD 713762, FSTC HT-23-437-70) Avail: NTIS CSCL 10/2

Expressions for calculating the flight weight of an aircraft generator using various cooling systems and with different generator drives have been formulated. The methods of calculating flight weight are cited in this article. TAB

N71-14669*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
NUMERICAL STUDY OF CONTROL OF DYNAMIC PROPERTIES OF A SUPERSONIC INLET USING BYPASS BLEED
Clarence W. Matthews Washington Jan. 1971 36 p refs
(NASA-TN-D-6144; L-7296) Avail: NTIS CSCL 20D

Several problems of supersonic-inlet control are discussed and it is decided that the use of an on-off bypass-door control

system linked to a flow property just ahead of the door would be beneficial for the control of the flow. Results computed by using one-dimensional unsteady-flow characteristic methods are presented. These results show that the bypass-door control system will control the flow when the engine-face mass-flow requirement is reduced to 0.2 for various stall cycles or to 0.6 for a throttle-chop transient. The bypass-door results are compared with those from a perforated-wall system and with those from a combination of both systems. Author

N71-14672*# Pratt and Whitney Aircraft, West Palm Beach, Fla. Research and Development Center.
SINGLE-STAGE EXPERIMENTAL EVALUATION OF COMPRESSOR BLADING WITH SLOTS AND VORTEX GENERATORS. PART 4: SUPPLEMENTAL DATA FOR STAGE 4
J. A. Brent 29 Dec. 1970 97 p
(Contract NAS3-10481)
(NASA-CR-72778; PWA-FR-4135-Pt-4) Avail: NTIS CSCL 01A

Data tabulations are presented on overall performance and bleed flow, blade element performance, and nomenclature used for blade elements. Author

N71-14701# *Toronto Univ. (Ontario). Inst. for Aerospace Studies.*
AN ASSESSMENT OF STOL TECHNOLOGY
Nov. 1970 290 p refs Prepared for Can. Transport Comm.
(UTIAS-162) Avail: NTIS

A study of STOL technology is presented in an attempt to identify impedances to the introduction of a Canadian STOL transport system. Five route types are considered (intercity, municipal feeder, downtown to airport, regional, and northern) and five major aspects of STOL are investigated (vehicle design and performance, operational aspects, navigation/guidance/air traffic control, nonpassenger public acceptance, and STOLports). As an aid in determining the viability of a Canadian system, economic models are developed for all but the Regional application. These models are applied to typical Canadian routes and the results presented in tabular and graphical form. An extensive bibliography covering all aspects of the STOL field has been compiled in support of this study and is included. Based on an analysis of the available information it is concluded that no major technological impedances exist that will prevent the introduction of a first generation STOL transport system based upon STOLports at grade level and turboprop vehicles with light wing loadings. However, the acceptance of such a system by the non-passenger public is not certain. Author

N71-14734*# Israel Program for Scientific Translations, Ltd., Jerusalem.
FIFTY YEARS OF SOVIET AIRCRAFT CONSTRUCTION
A. S. Yakovlev 1970 193 p refs Transl. into ENGLISH of the Book "50 Let Sovetskogo Samoletostroeniya" Moscow, Izdatel'stvo Nauka, 1970 p 1–186 Sponsored by NASA and NSF
(NASA-TT-F-627; TT-70-50076) Copyright. Avail: NTIS CSCL 01C

A history of U.S.S.R. aviation development and aircraft construction during a fifty year period is presented. Subjects discussed are: (1) aircraft design, (2) engine design, (3) industrial facilities, (4) civil aviation, (5) military aviation, and (6) accomplishments of flying personnel. Author

N71-14740*# Pratt and Whitney Aircraft, West Palm Beach, Fla. Research and Development Center.
SINGLE-STATE EXPERIMENTAL EVALUATION OF COMPRESSOR BLADING WITH SLOTS AND VORTEX GENERATORS. PART 3: DATA AND PERFORMANCE FOR STAGE 4
J. A. Brent 29 Dec. 1970 216 p refs
(Contract NAS3-10481)
(NASA-CR-72741; PWO-FR-3840) Avail: NTIS CSCL 01A

Stage 4 of a series of highly loaded stages was tested without slots and with slots and/or vortex generators to determine the extent that these devices could extent the stable operating range of an 0.8 hub/tip ratio subsonic axial flow compressor stage. At design equivalent rotor speed, pressure ratio and efficiency of slotted stage 4 with and without vortex generators were lower than the results obtained with the unslotted stage. The addition of vortex generators upstream of the rotor and between the rotor and stator of a stage comprised of unslotted rotor 4 and slotted stator 4 produced at 10% increase in stage stall margin at design speed. The peak pressure ratio remained about the same both with and without vortex generators, whereas, the addition of vortex generators resulted in a slight increase in peak efficiency. Author

N71-14754*# General Dynamics/Convair, San Diego, Calif.
MEASUREMENT OF RADIO FREQUENCY NOISE IN URBAN, SUBURBAN, AND RURAL AREAS Final Report
A. H. Mills Dec. 1970 184 p
(Contract NAS3-11531)
(NASA-CR-72802; GDC-AWV70-001) Avail: NTIS CSCL 17B

Measurements were made in the urban, suburban, and rural areas of Akron, Ohio, at ground level and from the air. Characteristics of 300 MHz, 1 GHz, and 3 GHz noise data were recorded using specialized instrumentation systems developed for this application. The measurements were taken during various time periods of the day and at various locations about the city. Author

N71-14755*# Houston Univ., Tex. Wave Propagation Labs.
ALTITUDE DEPENDENT RADAR RETURN STATISTICS
H. S. Hayre and R. F. Broderick [1970] 19 p refs
(Contract NAS9-9828)
(NASA-CR-114803; TR-68-10) Avail: NTIS CSCL 17I

The mean square value or the radar scattering cross section area of the radar return from a random rough surface is usually employed. In the case of decreasing altitudes, the area beamwidth covered by the radar may approach the dimensions of the order of the surface decorrelation distance whereupon the local surface mean and a variance have significant effect of the backscattered energy and its statistics. Simultaneous measurements from a scatterometer as well as a Doppler radar system mounted in a helicopter are used to illustrate this significant change in the radar return statistics. Author

N71-14792# Metaalinstituut TNO, The Hague (Netherlands).
INVESTIGATION OF THE CAUSE OF AN EXPLOSION IN THE MAIN MANOMETER AND THE COPPER PIPELINES OF AN OXYGEN BOTTLE CARRIER [ONDERZOEK NAAR DE OORZAAK VAN EEN EXPLOSIE IN DE PRIMAIRE MANOMETER EN DE KOPEREN AANSLUITLEIDINGEN VAN EEN ZUURSTOFFLESSENWAGEN]
P. Breedveld 3 Nov. 1970 4 p In DUTCH
(M70-777-BRE/LEE; A-70/KLu/067; TDCK-56605) Avail: NTIS

Spectrometric and microscopic examinations of a damaged copper feed pipe and monometer supplying the oxygen flow to the connection panel of high pressure oxygen bottles mounted onto carriers in military aircraft revealed the presence of glycerin. It is postulated that the manometer was calibrated with the help of glycerin and that this organic material upon sudden connection with the high pressure oxygen initiated spontaneous combustion. Transl. by G.G.

N71-14810# Institute for Defense Analyses, Arlington, Va. Urban Mass Transportation Project.
INTRA-AIRPORT TRANSPORTATION SYSTEMS: AN

EXAMINATION OF TECHNOLOGY AND EVALUATION METHODOLOGY
Dec. 1969 164 p refs
(Contracts DAHC15-67-C-0011; DOT-UT-43(IAA))
(AD-702738; IDA/HQ-69-10734; S-351) Avail: NTIS CSCL 1/5

The study examines the technology and analytic techniques available to provide assistance in arriving at solutions to intra-airport transportation problems. A number of proposed transportation systems are examined and their capabilities are compared to the future requirements of major U.S. airports. Technological deficiencies of proposed systems are identified, and possible major research, development, and demonstration programs are suggested. In addition, two typical airport transportation problems are identified, and simple analytical methods are developed for their solution. The applicability of both are analytical techniques and the available technology to other (non-airport) transportation problems is discussed. Author (TAB)

N71-14811# Schjeldahl (G. T.) Co., Northfield, Minn.
DESIGN AND MANUFACTURE OF COMPOSITE, ISOTENSOID, NATURAL SHAPE BALLOONS Final Report, May 1966 – Sep. 1969
James B. Munson 15 Dec. 1969 70 p refs
(Contract AF 19(628)-5987)
(AD-713188; AFCRL-70-0498; Rept-0034) Avail: NTIS CSCL 1/3

A method is presented for arranging filamentary, load bearing material to approximate a constant stress condition in the gas envelope of a free floating balloon for the purpose of maximizing structural efficiency. A relation between material distribution and envelope stress was obtained. Manufacturing equipment was developed and a natural shape, zero pressure constant stress balloon was fabricated and tested. Author (TAB)

N71-14817*# Mobil Research and Development Corp., Paulsboro, N.J.
MICROFOG LUBRICANT APPLICATION SYSTEM FOR ADVANCED TURBINE ENGINE COMPONENTS, PHASE 1. TASKS 1 AND 2: WETTABILITIES OF MICROFOG STREAMS OF VARIOUS LUBRICANTS AND OPTIMIZATION OF MICROFOG LUBRICATION
J. Shim and S. J. Leonardi 15 May 1970 87 p refs
(Contract NAS3-13207)
(NASA-CR-72743) Avail: NTIS CSCL 11H

Using the techniques and equipment previously developed, wettabilities of microfog streams of five high temperature lubricants on a static metal surface were determined under an inert atmosphere of nitrogen at temperatures ranging from 600 to 800 F. The wetting data are discussed in relation to the rate of oil-mist output, impaction velocity, temperature and surface characteristics of the wetted plate, and properties of the lubricants. Author

N71-14835# Little (Arthur D.), Inc., Cambridge, Mass.
A STUDY OF AIR TRAFFIC CONTROL SYSTEM CAPACITY Interim Report, Sept. 1969 – Aug. 1970
Gordon Raisbeck, Bernard O. Koopman, Simon F. Lister, and Asha S. Kapadia Oct. 1970 164 p refs
(Contract FA-70-WA-2141)
(FAA-RD-70-70) Avail: NTIS

The long-range objective of the program is to develop tools and techniques to define, measure, and predict the quantitative capacity of an air traffic control system, which can then be used in analytical studies in support of long-range plans, management decisions, and system performance evaluations. In the context of functional descriptions of air traffic control, the concepts of air traffic control system capacity include the following: (1) A functional description of air traffic control which is applicable to a wide range of system concepts, including the present system and many suggested variations and alternatives, is feasible. (2) The mathematical theory of time-varying queues is an important, useful tool. (3) The quantitative study of safety is highly relevant to ATC capacity, but must be studied indirectly rather than through accident statistics. (4) Simple, straightforward definitions of concepts, such as capacity, demand, delay, and safety, are unlikely, but the need for them can be satisfied by families of less comprehensive terms. Author

N71-14851*# General Electric Co., Cincinnati, Ohio. Aircraft Engine Group.
UNDISTORTED INLET FLOW TESTING. EVALUATION OF RANGE AND DISTORTION TOLERANCE FOR HIGH MACH NUMBER TRANSONIC FAN STAGES, VOLUME 1 Task 2 Stage Data and Performance Report
K. R. Bilwakesh Jan. 1971 205 p refs
(Contract NAS3-11157)
(NASA-CR-7278-Vol-1; GE-R70-AEG-427-Vol-1) Avail: NTIS CSCL 20D

A compressor stage consisting of a 1500 ft/sec tip speed rotor, a variable-camber inlet guide vane, and an adjustable stator, was tested with undistorted inlet flow at several inlet guide vane and stator settings. The objectives of the tests were to obtain blade element data and to evaluate the effectiveness of the variable geometry blading at several key points in an operating envelope typical of a Mach 3 turbofan engine. The overall performance and the blade element data obtained at the three combinations of IGV-stator settings at 50, 70, 80, 90, 100, and 110 percent design speed are presented in two volumes. Details of the test equipment, test procedure, data reduction methods, overall performance data and plots of blade element data are presented. Author

N71-14852*# General Electric Co., Cincinnati, Ohio. Aircraft Engine Group.
UNDISTORTED INLET FLOW TESTING. EVALUATION OF RANGE AND DISTORTION TOLERANCE FOR HIGH MACH NUMBER TRANSONIC FAN STAGES, VOLUME 2 Task 2 Stage Data and Performance Report
K. R. Bilwakesh Jan. 1971 290 p
(Contract NAS3-11157)
(NASA-CR-72787-Vol-2; GE-R70-AEG-421-Vol-2) Avail: NTIS CSCL 20D

The overall performance data and tabulations of blade element data obtained from tests of turbofan blade elements operating at Mach 3 are presented. The data were obtained for stator schedules of 50, 80, 90, 100, and 110 percent of design speed. Author

N71-14863*# General Electric Co., Cincinnati, Ohio. Aircraft Engine Group.
INLET FLOW DISTORTION TESTING. EVALUATION OF RANGE AND DISTORTION TOLERANCE FOR HIGH MACH NUMBER TRANSONIC FAN STAGES, VOLUME 1 Task 2 Stage Data and Performance Report
W. A. Tesch and V. L. Doyle Jan. 1971 125 p refs
(Contract NAS3-11157)
(NASA-CR-72786-Vol-1; GE-R70-AEG-426-Vol-1) Avail: NTIS CSCL 20D

A variable geometry stage consisting of a 1500 ft/sec tip speed, medium aspect ratio rotor, a variable camber inlet guide vane and a variable-stagger stator was tested under conditions of tip radial and 90 deg one-per-rev circumferential distorted inlet flow. Overall performance and stall limits were determined for each inlet condition at 70%, 90% and 100% of design speed. Extensive surveys of flow conditions were made for the case of circumferential distortion. In addition, blade element data were obtained when testing with radial distortion. Inlet distortion test results are presented and discussed. Author

N71-14864*# General Electric Co., Cincinnati, Ohio. Aircraft Engine Group.
INLET FLOW DISTORTION TESTING. EVALUATION OF RANGE AND DISTORTION TOLERANCE FOR HIGH MACH NUMBER TRANSONIC FAN STAGES, VOLUME 2 Task 2 Stage Data and Performance Report
W. A. Tesch and V. L. Doyle Jan. 1971 104 p
(Contract NAS3-11157)
(NASA-CR-72786-Vol-2; GE-R70-AEG-426-Vol-2) Avail: NTIS CSCL 20D

A variable geometry stage consisting of a 1500 ft/sec tip speed, medium aspect ratio rotor, a variable camber inlet guide vane and a variable-stagger stator was tested under conditions of tip radial and 90 deg one-per-rev circumferential distorted inlet flow. Overall performance and stall limits were determined for each inlet condition at 70%, 90% and 100% of design speed. Extensive surveys of flow conditions were made for the case of circumferential distortion. In addition, blade element data were obtained when testing with radial distortion. Inlet distortion test results are presented and discussed. Author

N71-14890*# Union Carbide Corp., Parma, Ohio. Carbon Products Div.
DEVELOPMENT OF SEAL RING CARBON-GRAPHITE MATERIALS, TASKS 1 AND 2
N. J. Fechter and P. S. Petrunich [1970] 118 p refs
(Contract NAS3-13211)
(NASA-CR-72799) Avail: NTIS CSCL 11A

Four material formulations, from which seal ring carbon-graphite bodies with a performance goal of 3000 hours life at air temperatures to 1300 F are to be produced, were ultimately developed after preparation and characterization of twelve material systems and forty-seven material subsystems. The material systems and subsystems employed four particulate and four binder raw materials selected after a literature search. Experimental results show: The oxidation rate of carbon-graphite bodies baked to 2800 C and prepared with a particulate system which contains a high concentration of relatively pure graphite is significantly lower than that of a commercial grade typical of current practice. The strength and hardness of these materials are lower than that of the commercial grade. The phenolic resin and coal tar pitch studied were more effective as binders than the furfuryl alcohol and polyphenylene sulfide resin. Graphite fibers can be used as an admixture for strengthening compacts prepared with an artificial graphite filler. Author

N71-14895# Bucher and Willis, Salina, Kans.
AIRPORT MASTER PLAN FOR CITY OF POPLAR BLUFF, MISSOURI
Dec. 1969 164 p Sponsored in part by Dept. of Commerce
(PB-189720) Avail: NTIS CSCL 01E

The purpose of this study is to inventory the present airport conditions, explore the probable airport usage by 1990 and to develop an airport plan to satisfy these estimated 1990 use demands. The findings of this study are summarized on the Poplar Bluff Airport Layout Plan and in this report. Author (USGRDR)

N71-14902# Army Engineer Waterways Experiment Station, Vicksburg, Miss.
RAPID ASSESSMENT OF AIRCRAFT LANDING SITES
Richard G. Ahlvin and George M. Hammitt, II 1970 14 p refs
(AD-713502) Avail: NTIS CSCL 1/5

The procedure described in the paper permits rapid survey of entire landing sites by use of any available standard ground vehicle. Specifically, the process is one of selecting a standard vehicle, such as a 2-1/2-ton cargo truck, traversing a potential landing area, and noting the rutting. From the degree of rutting, a direct projection of allowable operations of any aircraft can be readily determined. Author (TAB)

N71-14913# Naval Postgraduate School, Monterey, Calif.
SONOBUOY LOCATION
Thomas Penn French, Jr. Sep. 1970 77 p refs
(AD-713077) Avail: NTIS CSCL 17/1

In airborne anti-submarine warfare operations there is a critical requirement for maintaining an accurate relative plot of the sonobuoys with respect to the aircraft. This study proposed a method for locating sonobuoys in a pattern using aircraft-to-buoy slant range information. The method did not use triangulation procedures and attempted to minimize the restrictions placed on the aircraft. The study showed the feasibility of the proposed methodology and the approximate errors to be encountered. Author (TAB)

N71-14943*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
LOW-SUBSONIC AERODYNAMIC CHARACTERISTICS OF A SHUTTLE-ORBITER CONFIGURATION WITH A VARIABLE-DIHEDRAL DELTA WING
George M. Ware and Bernard Spencer, Jr. Washington Jan. 1971 44 p refs
(NASA-TM-X-2206; L-7566) Avail: NTIS CSCL 01A

An investigation has been conducted a low-turbulence pressure tunnel to determine the subsonic aerodynamic characteristics of a shuttle-orbiter configuration with a variable-dihedral delta wing. The tests were made at Reynolds numbers, basedon body length, 4.50 × 1 million to 26.54 × 1 million; the angles of attack varied from about −4 deg to 20 deg at 0 deg and 5 deg of sideslip. The variable investigated included the effects of wing dihedral angle, elevon deflection for pitch and roll control, vertical-tail size. Author

N71-14944*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
AN APPROACH TO THE DETERMINATION OF AIRCRAFT HANDLING QUALITIES BY USING PILOT TRANSFER FUNCTIONS
James J. Adams and Howard G. Hatch, Jr. Washington Jan. 1971 29 p refs
(NASA-TN-D-6104; L-7336) Avail: NTIS CSCL 01A

It is shown that a correlation exists between longitudinal closed-loop characteristics of a pilot-aircraft system (determined by using pilot models to represent the pilot) and pilot ratings obtained in flight tests. It is therefore concluded that pilot ratings can be predicted on the basis of the various levels of complexity of the models and the closed-loop system characteristics used in demonstrating the correlation. Author

N71-14945*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va
LOW-SPEED LONGITUDINAL AERODYNAMIC CHARACTERISTICS OF A MODEL OF A BLUNT-NOSE HYPERSONIC LIFTING SPACECRAFT HAVING VARIABLE-SPEED WINGS
Bernard Spencer, Jr. Washington Jan. 1971 31 p refs
(NASA-TM-X-2102; L-7357) Avail: NTIS CSCL 01A

An investigation has been made at low subsonic speeds of a model of a low-fineness-ratio lifting-body logistic spacecraft concept designed for a hypersonic lift-drag ratio near 1. Variable-sweep wings were employed and mounted in a low position. Tests were made in a low turbulence pressure tunnel at a Mach number of 0.21 and a Reynolds number of 30.4 × 1 million, based on model reference length. Angle of attack was varied from about −4 deg to 18 deg at 0 deg of sideslip. Author

N71-14981*# National Aeronautics and Space Administration. Langley Station, Va.
A SIMULATOR STUDY OF THE CONTROL OF LUNAR

FLYING PLATFORMS BY PILOT BODY MOTIONS
Paul R. Hill and David F. Thomas, Jr. Washington Dec. 1970 53 p refs
(NASA-TN-D-6016; L-7304) Avail: NTIS CSCL 05I

Results are presented of an investigation of body motion control of lunar flying platform configurations utilizing shirt-sleeved operators and a simulator with five degrees of freedom. The results show that lunar vehicles with moments of inertia up to 100 slug sq ft in pitch and 300 or 400 slug sq ft in roll should have satisfactory control qualities. The separation of the vehicle operator and thrust jets from the high inertia vehicle elements by means of a low inertia auxiliary platform resulted in satisfactory control in both pitch and roll over the range of equivalent lunar moments of inertia of 33 to 400 slug sq ft. A description of a number of useful variations of body motion control is presented. Author

N71-14988# Advisory Group for Aerospace Research and Development, Paris (France).
WIND TUNNEL PRESSURE MEASURING TECHNIQUES
P. S. Bynum (Aro, Inc.), R. L. Ledford (Aro, Inc.), and W. E. Smotherman (Aro, Inc.) Dec. 1970 99 p refs
(AGARD-AG-145-70) Avail: NTIS

A description of basic modern equipment and techniques available for wind tunnel pressure measurements is presented. Pressure measurements in wind tunnels are of interest not only for determining the pressure distribution on aerodynamic shapes, but also for determining test conditions in the wind tunnel test section. Wind tunnel pressure measurements are most frequently accomplished by use of transducers. A summary of the characteristics of the major types of pressure transducers is provided. Author

N71-15003*# National Aeronautics and Space Administration. Flight Research Center, Edwards, Calif.
VENTRICAL-TAIL LOADS AND CONTROL-SURFACE HINGE-MOMENT MEASUREMENTS ON THE M2-F2 LIFTING BODY DURING INITIAL SUBSONIC FLIGHT TESTS
Jerald M. Jenkins, Ming H. Tang, and George P. E. Pearson Washington Dec. 1968 24 p refs
(NASA-TM-X-1712) Avail: NTIS CSCL 01A

Subsonic aerodynamic load characteristics are presented for the right vertical tail and the control surfaces of the M2-F2 lifting body vehicle. The effects of vehicle attitude and control surface deflection on the vertical tail loads are determined. Coefficients defining the effects of angle or attack, angle of sideslip, upper flap deflection, and rudder deflection on flight measured vertical tail loads are presented in terms of linear equations. Portions of two maneuver time histories are presented to illustrate the magnitude of each of these effects. Author

N71-15143# Deutscher Wetterdienst, Offenbach am Main (West Germany).
REPORTS OF THE GERMAN METEOROLOGICAL SERVICES, VOLUME 16, NO. 116: THE AERONAUTICAL CONDITIONS AT INTERNATIONAL COMMERCIAL AIRPORTS [BERICHTE DES DEUTSCHEN WETTERDIENSTES, BAND 16, NR. 116: DIE FLUGKLIMATISCHEN VERHAELTNISSE AN INTERNATIONALEN VERKEHRSFLUGHAEFEN]
Hans Guss 1970 100 p refs In GERMAN; ENGLISH summary
Avail: NTIS

In the interests of the German commercial aviation the meteorological variables of state significant for take off and landing have been represented geographically in form of aeronautical climatological diagrams for airports from a great number of international commercial airports of all continents. Apart from a global view of the aeronautical climatological conditions of the most important commercial airports of the world these charts and their tables supplement the climatic monographies and climatic atlases, thus giving a better view almost of all climates of the earth. Author

N71-15151# Indian Inst. of Science, Bangalore. Dept. of Aeronautical Engineering.
DESIGN DATA ON BUCKLING OF SIMPLY SUPPORTED SKEW PLATES (ORTHOGONAL COMPONENTS). PART 1: INDIVIDUAL LOADING
Mahabaliraja and S. Durvasula Nov. 1970 71 p refs
(AE-248-S) Avail: NTIS

The design data on buckling of simply supported skew plates for individual loading cases are presented for a wide range of combinations of side ratio and skew angle. In-plane stresses are represented in terms of othogonal components. The mathematical analysis by Rayleigh-Ritz method expresses the deflection in terms of a double Fourier series of sine functions. The resulting matrix equation is divided into two groups corresponding to buckling modes which are skew-symmetric and skew-antisymmetric respectively. The lower of the two lowest eigenvalues from these two set of equations is the desired critical value. Convergence has been examined in a few typical cases. Numerical results for the buckling coefficients for three types of loading are presented in the form of tables and design curves. Author

N71-15152# National Aeronautical Establishment, Ottawa (Ontario).
TURBULENCE MEASUREMENTS IN AND NEAR THUNDERSTORMS
D. S. Treddenick Jun. 1970 24 p refs
(NRC-11703; LR-534) Avail: NTIS

In May of 1969, the NAE T-33 participated in a co-operative program of storm turbulence measurement. During the program, the T-33 made several thunderstorm penetrations in the vicinity of Tinker Air Force Base, Oklahoma. The aim of the program was to explore turbulence characteristics in and near thunderstorms and to correlate aircraft turbulence measurements with a ground based radar. Data recorded by the T-33 are used to compute true gust velocity time histories and to determine the variation in mean square gust velocities during the storm penetrations. Author

N71-15154# Aeronautical Research Labs., Melbourne (Australia).
SCATTER FACTORS IN AIRCRAFT FATIGUE LIFE ESTIMATION
B. C. Hoskin and D. G. Ford Apr. 1970 23 p refs
(ARL/SM-350) Avail: NTIS

An introduction is given to the question of scatter factors in aircraft fatigue life estimation. Considered is the fatigue scatter factor, which is the factor introduced to take account of the variation in life amongst nominally identical structures subjected to nominally identical fatigue loads. The choice of an appropriate probability distribution for fatigue life and the data which may be used in estimating the parameters in this distribution are discussed. An outline is given of the derivation of a formula for this scatter factor. Some reference is also made to the spectrum scatter factor which is designed to take account of the variability in loads experienced by different aircraft of the same fleet. Then, the combination of these two scatter factors into a total scatter factor is touched upon. Author

N71-15215# Army Missile Command, Redstone Arsenal, Ala. Physical Sciences Lab.
THE CHARACTERISTIC COEFFICIENTS TECHNIQUE FOR PROBABILITY MODELS OF WIND PROFILES IN MISSILE DESIGN AND ENVIRONMENT ANALYSIS
O. Essenwanger 1970 16 p refs
(AD-713522) Avail: NTIS CSCL 4/2

Three forms to describe global conditions for computer analysis of the wind influence upon missile systems have been common in the past: Individual wind profiles, intra and inter-level correlation matrices, and synthetic wind profile. All three methods show one or several kinds of deficiency: Voluminous data input, data bias, unrealistic vertical relationship, complex and costly

computation, or difficulty in associating probability. The above problems can be solved by the characteristic coefficient technique. The individual wind profile is described by a number of characteristic coefficients with subsequent reduction to one variable only. Three equations and a set of constants express completely the variety of global wind conditions and association with any wind probability threshold. Based upon the above tool sets of global wind models can be derived. The geographic and seasonal variation of a system of nine model groups is discussed and proves to be rational. Author (TAB)

N71-15267# Metaalinstituut TNO, The Hague (Netherlands).
EXAMINATION OF ALUMINUM PRESSURE CABLES PROTRUDING FROM F84 F AIRCRAFTS [ONDERZOEK VAN ALUMINIUM DRUKLEIDINGEN AFKOMSTIG VAN F84 F VLIEGTUIGEN]
G. P. C. Hazebroek and W. Hagg 12 Jun. 1970 6 p In DUTCH (TDCK-55807; M 70-407) Avail: NTIS

Visual and microscopic examinations of crack formations in aluminum spoiler cable structures established the cause as fracture-fatigue; cracklines were initiated by the presence of extrusion lines. Outward growing cracklines were also found in as yet unbroken cable structures. It was not possible to predict crackline growths into full cracks. Transl. by G.G.

N71-15301# National Bureau of Standards, Washington. Building Research Div.
WINDLOADS ON BUILDINGS AND STRUCTURES
Proceedings of Technical Meeting
R. D. Marshall and H. C. S. Thom (ESSA, Silver Spring, Md.), eds. Nov. 1970 171 p refs Conf. held in Gaithersburg, Md., 27–28 Jan. 1969 *Its* Bldg. Sci. Ser. 30
Avail: SOD $1.75 Catalog No. C-13.29/2:30

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N71-15306# Colorado State Univ., Fort Collins. Fluid Dynamics and Diffusion Lab.
FLUCTUATING MOMENTS ON TALL BUILDINGS PRODUCED BY WIND LOADING
J. E. Cermak, W. Z. Sadeh, and G. Hsi *In* NBS Windloads on Bldg. and Struct. Nov. 1970 p 45–59 refs Supported in part by Metronics Associates, Inc.
Avail: SOD $1.75 Catalog No. C-13.29/2:30

Wind loading on a 1:384 scale model of a building 666 ft high was studied experimentally in a thick-boundary-layer wind tunnel. Measurements of mean velocity and turbulence intensity upstream of the model building verified that the wind tunnel flow was an adequate simulation of atmospheric surface-layer flow over an urban area. Mean pressure distributions and local pressure fluctuations were measured for a variety of upstream roughness conditions and wind direction. Use of a high frequency response pressure-measuring system permitted rms and peak values of the local pressure fluctuations to be determined at numerous points on the building surface. Emphasis was placed on direct measurement of mean and fluctuating overturning moments by means of a strain gage dynamometer. Peak values of the moment fluctuations were found to have a magnitude of + or − 34% of the mean moment. Root-mean-square values of the moment fluctuations were also determined in an effort to relate the moment fluctuations to the measured pressure fluctuations. Author

N71-15307# National Research Council of Canada, Ottawa (Ontario). Div. of Building Research.
EXPERIENCE WITH WIND PRESSURE MEASUREMENTS ON A FULL-SCALE BUILDING
W. A. Dalgliesh *In* NBS Windloads on Bldg. and Struct. Nov. 1970 p 61–71 refs
Avail: SOD $1.75 Catalog No. C-13.29/2:30

Wind pressure measurements made over a four year period on a 34 story building were used to obtain data for checking and improving wind tunnel techniques of modeling flow characteristics of wind and aerodynamic behavior of buildings. The major problems involved in making field measurements and in comparing them with wind tunnel measurements were found to be: (1) difficulty of establishing a static reference pressure and its relation to the static pressure in the wind tunnel; (2) inadequacy of wind velocity information; (3) lack of stationarity and homogeneity of the velocity field as compared with the wind tunnel situation. Comparisons with model measurements on the basis of mean pressures, rms pressures, power spectra, and the correlation between selected pairs of pressures measured at various points on the building have been found of excellent agreement in almost all respects; for some sind directions the comparisons gave unsatisfactory correlations. The lack of agreement was attributed mainly to differences between indicated and actual on-site wind direction. Author

N71-15311# Skilling, Helle, Christiansen, Robertson, New York, N.Y.
THE TREATMENT OF WIND IN THE DESIGN OF VERY TALL BUILDINGS

Leslie E. Robertson and Peter W. Chen *In* NBS Windloads on Bldg. and Struct. Nov. 1970 p 107–114 refs

Avail: SOD $1.75 Catalog No. C-13.29/2:30

Described are some highlights of a study of the wind effects for the design of the United States Steel Office Building in Pittsburgh, Pennsylvania. Three types of models were used in a boundary layer wind tunnel to obtain data of the wind effects on the building. The wind tunnel results were combined with Weather Bureau data to obtain statistical estimates of the design parameters. These parameters included the envelopes of maximum deflections, the contours of maximum and minimum wind pressures on the exterior walls, and the expected number of cycles of oscillation per year which exceeds specific values of acceleration and of deflection. Author

N71-15312# Ammann and Whitney, New York.
DYNAMIC RESPONSE OF TALL FLEXIBLE STRUCTURES TO WIND LOADING
Joseph Vellozzi and Edward Cohen *In* NBS Windloads on Bldg. and Struct. Nov. 1970 p 115–128 refs

Avail: SOD $1.75 Catalog No. C-13.29/2:30

Presented and discussed are methods of calculating the dynamic responses of tall, flexible structures, such as towers, stacks and masts, to wind loading. The first part deals with the dynamic responses of cylindrical structures to vortex shedding and the second part deals with dynamic responses to gust loading. Author

N71-15314# California Univ., Los Angeles.
COMBINING A WIND TUNNEL ANALYSIS WITH A THREE-DIMENSIONAL ANALYTIC BUILDING ANALYSIS
Gary C. Hart *In* NBS Windloads on Bldg. and Struct. Nov. 1970 p 145–149 refs
Avail: SOD $1.75 Catalog No. C-13.29/2:30

A three-dimensional computer oriented stiffness representation of a high-rise building is described. Statistical quantities obtained from aeroelastic models in a boundary layer wind tunnel are combined with the three-dimensional analytical building model to obtain a probabilistic description of the building's response. The response is expressed in terms of the mean and covariance of floor displacements and stresses in the structural members. The procedure is intended to provide a more realistic combination of the aerodynamic and structural behavior of a high-rise building. Author

N71-15341*# Stanford Univ., Calif. Dept. of Aeronautics and Astronautics.
THEORETICAL CONSIDERATIONS OF SOME NONLINEAR ASPECTS OF HYPERSONIC PANEL FLUTTER Annual Report, 1 Sep. 1967–31 Aug. 1968
S. C. McIntosh and J. I. Lerner 31 Aug. 1968 42 p refs
(Grant NGR-05-020-102)
(NASA-CR-115854; AR-3) Avail: NTIS CSCL 20K

The stability and response of a panel of infinite width on hinged supports, including a critical evaluation of the important nonlinear aerodynamic terms and the effects of turbulent boundary layer are discussed. Purposes of the research project are: (1) to study the effects on panel response and stability of nonlinear, nonviscous aerodynamic loading at hypersonic Mach numbers and (2) to determine theoretically the effects of turbulent boundary layer on the aerodynamic loading of an oscillating panel. Author

N71-15372# Royal Aircraft Establishment, Famborough (England).
SIMULATION OF AERIAL COMBAT [SIMULATION VON LUFTKAEMPFEN]
Juerg Kohlas (Ph.D. Thesis–Zuerich Univ., 13 Feb. 1967) Oct. 1969 106 p refs Transl. into ENGLISH of German thesis
(RAE-Lib-Trans-1367) Avail: NTIS

The analysis of the probability of survival is an important part of the evaluation of the effectiveness of fighters. There are three interdependent aspects to be considered in the study of the probability of survival against hostile interceptors, namely the problems of encounter, detection, and success or failure after detection. Every pilot controls his aeroplane according to a set of tactical decision rules taking into consideration present and past information of the air combat. Several sets of decision rules corresponding to distinct tactics may be provided. Aeroplanes are controllable in the three-dimensional space and their axial acceleration can be controlled through regulation of the thrust. Several aeroplanes may be engaged on both sides in an air combat. Some examples of flight paths have been computed and their graphs are displayed in the text. Author

N71-15380*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
TURBOJET-RAMJET PROPULSION SYSTEM FOR ALL-BODY HYPERSONIC AIRCRAFT
Mark H. Waters Washington Jan. 1971 53 p refs
(NASA-TN-D-5993; A-3668) Avail: NTIS CSCL 21A

The characteristics of a parallel, over-and-under, turbojet-ramjet propulsion system installed on an all-body Mach number 6 hypersonic aircraft are estimated, and the effect of variations in propulsion system parameters on payload and on problems of installation are determined. Engine thrust and fuel flow requirements are evaluated throughout acceleration and cruise, and the effects on the weights and dimensions of the propulsion system, including both inlets and engines, are determined. A wraparound turboramjet is also evaluated and comparisons with the parallel turbojet-ramjet system are made. Author

N71-15390# Civil Aeronautics Board, Washington, D.C.
ADDRESS BY THE HONORABLE ROBERT T. MURPHY, MEMBER, CIVIL AERONAUTICS BOARD, BEFORE THE GOVERNOR'S TRANSPORTATION CONFERENCE: PRESS RELEASE
Robert T. Murphy 26 Aug. 1970 8 p Conf. held in Caspar, Wyo., 25 Aug. 1970
Avail: Issuing Activity

A discussion is presented concerning the problems confronting local airlines in providing service to rural areas of the United States. The possibilities are explored for providing commuter airline service particularly to some of the growing Wyoming communities which do not presently have air service. Major emphasis is placed on arrangements for substitution of third level commuter airlines for the services of scheduled certificated carriers. D.L.G.

N71-15391# Army Electronics Command, Fort Monmouth, N.J.
THE DEVELOPMENT OF A KALMAN FILTERING ALGORITHM FOR HYBRID NAVIGATION IN ARMY AIRCRAFT
Joseph A. Knight 1970 14 p refs
(AD-713553) Avail: NTIS CSCL 17/7

Control system solutions have been formulated using Kalman filtering -- a data processing technique whereby a dynamic error model of the system, as well as the statistical parameters of the instrumentation and measurement noise, are combined in a state space equation to estimate the system errors. Hybrid navigation is a natural candidate for such control techniques and several studies have been made in this general area although no systems designed for Army aircraft have been flown. This paper will present the analytical results obtained in the first phase of a US Army program to determine the feasibility of hybrid navigation for Army purposes. The program will culminate in flight tests in 1970-71. The paper

will address four major areas: synoptic statement of Kalman filter principles, general determination of needs unique to the Army, error model analysis of the candidate navigation subsystem, and development of the Kalman filter algorithm. Author (TAB)

N71-15392# Honeywell, Inc., Minneapolis, Minn. Systems and Research Center.

AIRCRAFT OPTIMUM MULTIPLE FLIGHT PATHS Final Technical Report, May 1969 - May 1970

Robert L. Schultz and Philip S. Kilpatrick JANAIR Jun. 1970 138 p refs

(Contract N00014-69-C-0339)

(AD-713136; JANAIR-700709; Rept-12602-FR) Avail: NTIS CSCL 17/7

The objectives of the study are to apply existing optimization techniques of modern control theory to compute aircraft trajectories and to define an approach to implement the results into an improved military air traffic management (ATM) system. The recommended concept provides positive control of the airspace by acquiring aircraft formations, determining aircraft positions, assigning landing priorities, calculating optimum trajectories subject to constraints, and transmitting steering commands to the aircraft. Although the concept is developed in terms of an aircraft carrier operational setting and the analysis concentrates on minimum fuel trajectories, the concept is generally applicable to military ATM problems such as Army helicopters or fixed wing aircraft in the vicinity of an airbase, and the analysis techniques are candidates for other aircraft optimization problems such as minimum time-to-climb or minimum time-to-descent trajectories. The purpose of this concept is to increase overall operational capability by increasing the overall range or time-over-target of aircraft, reducing the threat to aircraft carriers, and simplifying and automating ATC procedures for pilots and controllers. An analytical approach was developed in this study to reduce the complexity of the optimum trajectory calculation so that acceptable accuracy is achieved with minimal computer capacity. The optimum trajectories are computed by an iterative solution technique that converges rapidly to the final trajectory. Author (TAB)

N71-15393# Houston Univ., Tex. Dept. of Mechanical Engineering.

SIMULATION WITH MINIMUM EQUIPMENT OF RANDOM VIBRATION INDUCED BY COMPLEX EXCITATION

O. E. Crenwelge, Jr. and D. Muster Aug. 1970 19 p refs

(Contract Nonr-4492(01))

(AD-713141; TR-22) Avail: NTIS CSCL 20/11

Complete simulation of random response induced in service by complex, ergodic, Gaussian excitation requires the exact reproduction of the response spectral densities at all points of the system and the cross-spectral densities between each pair of points. This in turn requires exact reproduction of the service loading. If a less-than-complete exact simulation of the response spectra at and between n system locations is acceptable, this can be accomplished using n discrete random forces. For certain types of systems previous theorization has shown that one discrete random force can be used to produce simulation which is accurate in the neighborhood of the resonance frequencies and approximate in the vicinity between resonance peaks. These systems must have light damping and widely spaced resonances so that modal coupling does not exist. The discrete random simulation force must have the appropriately shaped spectrum and must be properly located so that all modes will be excited. For systems of this type the theory shows that reproduction of the response spectral density at any one point assures reproduction of the spectral and cross-spectral densities at and between all other points. Author (TAB)

N71-15422*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

AN IMPROVED ANALYTICAL TREATMENT OF THE DENTING OF THIN SHEETS BY HAIL

Robert G. Thomson and Robert J. Hayduk Washington Jan. 1971 47 p refs

(NASA-TN-D-6102; L-7343) Avail: NTIS CSCL 20K

Severe structural damage, such as surface erosion, dents, perforations, and tears, can occur when high speed aircraft collide with hailstones. The denting of aircraft skin by hail is mathematically analyzed and the results are compared with experimental data. The denting process is modeled mathematically by assuming that a crushable, spherical hailstone impacts normal to a flat sheet. The resultant dent depth and shape are determined by utilizing an existing computer program which considers both bending and membrane action and elastic and plastic material behavior. The results of this analysis are compared with experimental data from the British Royal Aircraft Establishment and with a previous analysis which considered bending only. The improved analytical treatment of the denting process agrees well with the experimental data and shows that membrane forces must be considered when sheet deflections are large. Author

N71-15428# Air Force Systems Command, Wright-Patterson AFB, Ohio. Flight Dynamics Lab.

TWO INDEPENDENT CALIBRATION METHODS USED IN TESTING LOW MASS FLOW RATE SENSORS IN ELECTROGASDYNAMIC FACILITIES Technical Report, Apr. 1963 Apr. 1966

D. W. Young Aug. 1970 53 p refs

(AD-713625; AFFDL-TR-70-60) Avail: NTIS CSCL 14/2

Development of a system for measuring the mass flux profiles in an arc heated gasdynamic wind tunnel is described. Two independent calibration systems were developed for calibrating the low mass flow rate meter. One system is based on the pressure rise method and the other on the positive displacement technique. A combination mass flux and impact pressure probe was designed and utilized as a flow diagnostic instrument. The mass flux measuring system was capable of measuring rates of flow from .00000025 to .0004 pounds per second at test section simulated altitudes of 160,000 feet. Dynamic response of the flowmeter permitted continuous traverses of the core of the flow at speeds of 0.5 inch per second. Comparisons are made between mass flow rates as measured by the facility mass flowmetering system and those obtained by integrating the mass flux probe data. Author (TAB)

N71-15465# Colorado State Univ., Fort Collins. Fluid Dynamics and Diffusion Lab.

AIR FLOW OVER ROUGHNESS DISCONTINUITY

Fei-Fan Yeh and E. C. Nickerson Jul. 1970 142 p refs

(Contract N00014-68-A-0493-0001; Proj. Themis)

(AD-712113; CER70-71FFY-ECN6; Themis-CER-TR-8) Avail: NTIS CSCL 20/4

Measurements of mean velocity, mean-square turbulent velocity, turbulent shear stress, one-dimensional spectrum, and mass concentration distributions following a step increase in surface roughness of a wind-tunnel boundary-layer flow are presented. The mean velocity distributions agree well with Nickersons numerical calculations for a small roughness change. The mixing-length distribution in the transitory region is not experimentally consistent with that established for fully-developed turbulent boundary layer. Turbulent intensity and shear stress are generated progressively towards the upper layer as one moves downstream from the roughness discontinuity. The high frequency end of the spectra in the transitory region can be exactly represented by the high frequency shape of the undisturbed turbulent boundary layer. Self-preserving mass concentration profiles are in general possible for both the vertical and horizontal distributions. The adjustment of the mean motion to the roughness change is more rapid than that of the turbulence. Author (TAB)

N71-15498# National Aviation Facilities Experimental Center, Atlantic City, N.J.
INVESTIGATION OF TRANSPONDER REPLY FADE-OUT IN THE VICINITY OF CHICAGO O'HARE AIRPORT Interim Report, Mar. – May 1970
George F. Spingler Dec. 1970 54 p
(FAA-RD-70-75; FAA-NA-70-49) Avail: NTIS

The results of flight tests in the vicinity of O'Hare Airport, Chicago, Illinois to determine the cause of transponder fading are presented. Analysis of the flight test data showed that the major cause of the coverage problem centered around the towers of a remote transmitter site and propagation vertical lobing. Author

N71-15548# National Aerospace Lab., Amsterdam (Netherlands).
SOME ANALYTICAL AND NUMERICAL CALCULATIONS FOR A CYLINDER-VORTEX COMBINATION IN INCOMPRESSIBLE FLOW
H. Kramer Jul. 1969 19 p refs
(NLR-TR-69057-U) Avail: NTIS

Velocity- and pressure-distributions over a circular cylinder crossed by a line vortex at right angles were determined by numerical evaluation of analytical expressions. The results are compared with numerical results of the panel method using a surface distribution of sources. Based on this comparison the influence of variations in the panel distribution on the accuracy of the numerical results was investigated. Author

N71-15553*# Alabama Univ. Research Inst., Huntsville. Div. of Graduate Programs and Research.
HUNTSVILLE AIR TRAFFIC FORECAST
David G. Mishkin Oct. 1970 40 p
(Grant NGL-01-002-001)
(NASA-CR-115880; UARI-93) Avail: NTIS CSCL 17G

Huntsville's air passenger traffic is growing at a slower rate than the national average and is not expected to approach the United States' growth rate until 1975. The destinations of Huntsville's originating passengers are forecast to remain relatively unchanged until 1980. Additional data was generated by an onboard survey of departing passengers from the Huntsville-Madison County Jetport This information has been stored on computer cards and will serve as the first in a series of Huntsville air passenger studies. The survey points up the relative importance of NASA, military, and contractor passengers to Huntsville markets. In addition, the survey measures factors that affect the jetport itself, such as transportation choice to the airport, and residence of originating passengers. Author

N71-15557*# Old Dominion Univ. Research Foundation, Norfolk, Va.
TRANSPORTATION NOISE POLLUTION: CONTROL AND ABATEMENT
David O. Dickerson, Franklin D. Hart, J. Darrell Gibson, and Chester E. Jarvis 1970 204 p refs
(Grant NGT-47-003-028)
(NASA-CR-115881) Avail: NTIS CSCL 13B

In a comprehensive attack on the problem of transportation noise pollution, this report discusses the nature of noise and its detrimental effects; projected transportation trends for the next fifteen years and the resulting impact on the noise environment; legal and political aspects of the noise problem; and positive recommendations for controlling and abating transportation noise pollution. Author

N71-15558# Stanford Research Inst., Menlo Park, Calif.
A METHODOLOGY FOR EVALUATING THE CAPACITY OF AIR TRAFFIC CONTROL SYSTEMS Annual Report, Sep. 1969 – Aug. 1970
R. S. Ratner et al Oct. 1970 182 p refs
(Contract FA-70-WA-2142)
(FAA-RD-70-69; AR-1) Avail: NTIS

Results obtained in the first year of a multiyear project to develop a methodology for evaluating the capacity of air traffic control systems are described. The meaning of capacity in an ATC system and the relationship of capacities of functional and geographical system elements to system capacity measures is qualitatively analyzed. Capacity is defined in terms of aircraft movement numbers and rates as limited by a number of factors, including safety and performance. The need for a family of computer-based capacity evaluation models is identified, to balance the fidelity required in modeling the ATC process for capacity assessment, against the heavy computational requirements of such modeling. A decomposition concept is applied to achieve this balance. The conceptual design of members of the family, and some preliminary algorithm development, are reported. Members of the family of models are designed to measure each of the capacity limitations associated with system operating strategies, scheduling, and routing, with delays resulting from congestion, with flow control techniques, with separation minima, control procedures, and other safety aspects as they affect aircraft flight paths, and to measure the delays and aircraft movement limitations associated with high workload models. Author

N71-15563* Lockheed-California Co., Burbank.
ABSORPTIVE SPLITTER FOR CLOSELY SPACED SUPERSONIC ENGINE AIR INLETS Patents
Howard Kastan, inventor (to NASA) Issued 6 Sep. 1966 (Filed 8 Dec. 1964) 5 p Cl. 244-53 Sponsored by NASA
(NASA-Case-XLA-02865; US-Patent-3,270,990;
US-Patent-Appl-SN-416946) Avail: US Patent Office CSLC 21A

An absorptive barrier assembly to be mounted between closely spaced jet engines is described for preventing interference effects due to shock waves from the engines. The barrier includes a solid plate which isolates the air inlets by preventing shock waves generated by one engine from reaching the other. In addition the barrier is nonreflective and does not reflect shock waves back to the engine generating the waves. The barrier is made nonreflective by attaching perforated arcuate side panels to each side of the solid plate. N.E.N.

N71-15577# Aeronautical Research Labs., Melbourne (Australia).
ADDRESS INDICATOR FOR A PRESSURE SCANNER
H. Mokotow Apr. 1970 27 p refs
(ARL/ME-314) Avail: NTIS

A numeric display provided by an address indicator was designed to identify the port of a forty-eight channel pressure scanner. This display is part of the data logging equipment used with the supersonic intake rigs. Author

N71-15582* National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
CONTROL SYSTEM FOR ROCKET VEHICLES Patent
Norman L. Crabill and John M. Riebe, inventors (to NASA) Issued 6 Sep. 1966 (Filed 21 Oct. 1964) 6 p Cl. 60-35.55
(NASA-Case-XLA-01163; US-Patent-3,270,505;
US-Patent-Appl-SN-405632) Avail: US Patent Office CSCL 22A

A system for aerodynamic control of an exhaust stream nozzle is described. The control system utilizes secondary injection of a fluid into the exhaust stream, and the injection hardware is located on a swiveling nozzle to provide inertial lag of the system when the vehicle is disturbed. R.B.

N71-15636# Water Resources Engineers, Inc., Walnut Creek, Calif.
EROSION CONTROL ON AIR FORCE BASES, JANUARY 1969 - JULY 1970
Delynn R. Hay, D. F. Kibler, and C. E. Busby Kirtland AFB,

N.Mex. AFWL Aug. 1970 25 p refs Presented at Am. Soc. of Agron. Ann. Meeting, Tuscon, Ariz., 24-28 Aug. 1970
(Contract F29601-69-C-0039)
(AD-713644; WLC-TN-70-018) Avail: NTIS

A state-of-the-art review of the soil erosion field as it relates to the erosion control needs of the US Air Force was conducted. The review will serve as a guide for preparation of a Base Civil Engineer erosion control handbook. Typical military construction activities which have exposed large areas of unprotected soil and subsequently have led to serious erosion problems are presented. Factors involved in the wind and erosion processes are discussed and soil-loss equations and soil erodibility indices are reviewed. The erodibility K-factor in the ARS soil-loss equation is evaluated for land management planning techniques. Guidelines for effective erosion control practices to protect exposed land surfaces against soil particle detachment and transport by either water or wind are presented. Further efforts to establish a more reliable erodibility index which can be used to define areas of highly erodible soils, especially for subsurface soils that are exposed during construction are indicated. Author (TAB)

N71-15649# Congress. Senate. Committee on Government Operations.
TFX CONTRACT INVESTIGATION FROM PERMANENT SUBCOMMITTEE ON INVESTIGATIONS
John L. McClellan Washington GPO 1970 100 p refs Rept. presented by the Comm. on Govt. Operations at the 91st Congr., 2nd Sess., 18 Dec. 1970
(Rept-91-1496) Avail: US Capitol, Senate Document Room

Congressional investigations into the TFX contract award is reported, including a brief summary of the origin of the variable sweep airplane and the original military requirements. The research and development program is examined, and includes early discovery of major technical design problems which led to recommendations to redesign the F-111B. Test pilots' warnings of serious problems from 1965 to 1967 are summarized. The costs of the program and an analysis of the contracts are discussed. An overall summary of the TFX program and the conclusions reached from the hearings are presented. R.B.

N71-15698*# California Univ., Davis. Dept. of Mechanical Engineering.
CONTROL POWER REQUIREMENTS OF VTOL AIRCRAFT, PHASE 1 STUDY Final Report, Apr. 1969 - Sep. 1970
M. A. Hoffman, W. V. Loscutoff, and J. Seevers Nov. 1970 208 p refs
(Grant NGR-05-004-051)
(NASA-CR-115907) Avail: NTIS CSCL 01A

A two part program is reported aimed at the development of a modern guidance, control, and stabilization system for the VTOL aircraft. The first part of the program deals with design and cost aspects of three specific types of VTOL transports. The three types of VTOL's selected were a tilt-wing design and two pure-jet-lift designs, one with all lift engines in the fuselage and the other with the lift engines in wing pods. Computer programs were written to design the vehicles and calculate the direct operating costs for each of the three types. The data obtained was used to assess the cost of increasing the installed propulsive power for control purposes. The second part of the investigation focused on the control problems of VTOL transports. A study was initiated to explore several promising analytical control system design techniques with the initial effort being directed toward VTOL hover control systems. The various types of control methodology are described and results of the system design study are given. D.L.G.

N71-15701# National Physical Lab., Teddington (England). Aerodynamics Div.
ON ACHIEVING INTERFERENCE-FREE RESULTS FROM DYNAMIC TESTS ON HALF-MODELS IN TRANSONIC WIND TUNNELS
A. W. Moore and K. C. Wight London Aeron. Res. Council 1970 32 p refs Supersedes NPL-AERO-1293; ARC-31049
(ARC-R/M-3636; NPL-AERO-1293; ARC-31049) Copyright. Avail: NTIS; HMSO: 80p; BIS: $3.20

An interference-free datum for oscillatory pitching derivatives was deduced from tests on a small half-model in three ventilated tunnels. The large dynamic interference in a smaller slotted tunnel was reduced to small proportions at all speeds when perforated screens were fitted behind the slots. Corrected results for side-wall boundary layer effects agreed with measurements made with the boundary layer thinned locally by vortex generators. Author (ESRO)

N71-15702# Royal Aircraft Establishment, Farnborough (England). Aerodynamics Dept.
A LOW-SPEED WIND-TUNNEL INVESTIGATION OF THE TAILPLANE EFFECTIVENESS OF A MODEL REPRESENTING THE AIRBUS TYPE OF AIRCRAFT
D. A. Lovell London Aeron. Res. Council 1970 44 p refs Supersedes RAE-TR-69077; ARC-31507
(ARC-R/M-3642; RAE-TR-69077; ARC-31507) Copyright. Avail: NTIS; HMSO: £ 1.10; BIS: $4.05

Lift, drag, and pitching moment measurements were made on a model having three tailplane heights and three wing configurations, with and without the tailplane in position. Wake and boundary-layer surveys at the tailplane heights and a separate force and moment test of the isolated tailplane were also made. The tailplane efficiency was determined for the three tailplane heights. The interference involved in mounting the tailplane on the model was negligible with the tailplane mounted away from the body. With the tailplane mounted on the large body the interference was small and no evidence of extensive flow separation was found. Author (ESRO)

N71-15703# National Physical Lab., Teddington (England). Aerodynamics Div.
THEORETICAL LIFT-DEPENDENT YAWING MOMENT ON A SWEPT WING IN SUBSONIC FLOW WITH SPANWISE ASYMMETRY
H. C. Garner Jan. 1970 16 p refs
(NPL-AERO-NOTE-1084; ARC-31757) Copyright. Avail: NTIS

Classical lifting-line theory shows that the yawing moment should depend only on the spanwise loading but application to a tapered swept wing at incidence with linear antisymmetrical twist gives values 60% in excess with correct total drag. When the static twist is replaced by an equivalent steady rolling motion to give the same wing loading, the yawing moment has different sign and is underestimated by 50% if the simpler theoretical approach is used. Author (ESRO)

N71-15704# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Goettingen (West Germany).
EXPERIMENTAL INVESTIGATION OF FORCES ON SIMPLE LIFTING BODIES IN RAREFIED HYPERSONIC FLOW [EXPERIMENTELLE UNTERSUCHUNG DER KRAEFTE AN EINFACHEN FLUGKOERPERN BEI VERDUENNTER HYPERSCHALLSTROEMUNG]
G. Koppenwallner Jul. 1970 43 p refs In GERMAN; ENGLISH summary Sponsored by Bundesmin. fuer Bildung und Wiss.
(BMBW-FB-W-70-41) Avail: NTIS; ZLDI Munich: 8,60 DM

Force measurements on cones, cone-cylinders, an integral Junkers lifting body, and a sharp edged delta wing were carried out in a hypersonic low density wind tunnel. Mach numbers ranged from 7 to 22 with gas stagnation temperatures from 300 K to 1600 K. The simulated Reynolds number range was in the slip flow region. The construction and calibration of a water-cooled three component strain-gage balance is described. Author (ESRO)

N71-15705# Royal Aircraft Establishment, Bedford (England). Aerodynamics Dept.

A FORM OF LATERAL INSTABILITY OF LIFTING FREE-FLIGHT MODELS TOWED BY A HELICOPTER

W. J. G. Pinsker London Aeron. Res. Council 1970 18 p refs Supersedes RAE-TR-68247; ARC-31273

(ARC-R/M-3641; RAE-TR-68247; ARC-31273) Copyright. Avail: NTIS; HMSO: 45p; BIS: $1.80

Experiments on unstable lateral pendular oscillations when towed above a certain speed are described. A mathematical model, considering only roll angle and lateral displacement of the model, gave results in agreement with flight observation. Critical speed prediction is discussed along with design parameters for increasing the speed range in which stable tow is possible. Author (ESRO)

N71-15706# Royal Aircraft Establishment, Farnborough (England). Aerodynamics Dept.

LOW-SPEED WIND-TUNNEL TESTS ON A WING SECTION WITH PLAIN LEADING- AND TRAILING-EDGE FLAPS HAVING BOUNDARY-LAYER CONTROL BY BLOWING

J. A. Lawford and D. N. Foster London Aeron. Res. Council 1970 36 p refs Supersedes RAE-TR-69078; ARC-31371

(ARC-R/M-3639; RAE-TR-69078; ARC-31371) Copyright. Avail: NTIS; HMSO: 90p; BIS: $3.50

The tests were made in almost two dimensional conditions and the increases of lift were measured for a range of flap deflections. The effectiveness of a leading edge flap for increasing the stalling incidence and maximum lift coefficient was also studied. Inviscid theory pressure distribution predictions agreed with the data and suggest that minimum aerodynamic drag occurs when the inviscid lift is achieved. Author (ESRO)

N71-15707# National Physical Lab., Teddington (England). Aerodynamics Div.

EXPERIMENTAL VERIFICATION OF PREDICTED STATIC HOLE SIZE EFFECTS ON A MODEL WITH LARGE STREAMWISE PRESSURE GRADIENTS

P. G. Pugh, J. W. Peto, and L. C. Ward Feb. 1970 19 p refs

(NPL-AERO-1313; ARC-31900) Copyright. Avail: NTIS

Spherically-blunted cone surface pressure data are used to demonstrate a simple method for correcting finite static hole size effects over the spherical portion of the model. Author (ESRO)

N71-15708# Royal Aircraft Establishment, Bedford (England). Aerodynamics Dept.

TESTS AT A MACH NUMBER OF 2.0 ON A RECTANGULAR, TWIN-DUCT AIR INTAKE WITH VARIABLE GEOMETRY, SITUATED IN THE FLOW FIELD OF A SLENDER WING

M. D. Dobson London Aeron. Res. Council 1970 40 p refs Supersedes RAE-TR-68285; ARC-31118

(ARC-CP-1122; RAE-TR-68285; ARC-31118) Copyright. Avail: NTIS; HMSO: 50p; BIS: $2.00

The intake performance was assessed in a wind tunnel and effects in one duct, due to flow variations through the other, were also investigated. Partial immersion of the intake into a wing boundary layer caused little performance degradation and even small increases of pressure recovery were noted. Interference effects may be sensitive to small crossflow angles at the intake. Smaller margins of mass flow reduction without interference were observed when the windward duct was throttled. The design of the leading edge of the wall which separates the two ducts (splitter), affected the interference characteristics. Author (ESRO)

N71-15720# Royal Aircraft Establishment, Farnborough (England). Avionics Dept.

THE USE OF CROSS-CORRELATION AND POWER SPECTRAL TECHNIQUES FOR THE IDENTIFICATION OF THE HUNTER Mk.12 DYNAMIC RESPONSE

D. E. Fry London Aeron. Res. Council 1970 43 p refs Supersedes RAE-TR-69156; ARC-31760

(ARC-CP-1121; RAE-TR-69156; ARC-31760) Copyright. Avail: NTIS; HMSO: 11s [55p]; BIS: $2.20

A method of identifying the short-period longitudinal transfer function and impulse response of the Hunter Mk.12 from flight data, using cross-correlation and power spectral techniques, is described. The input was a pilot-induced pseudo-random binary sequence on the elevator via the control column, and the output was the pitch rate response of the aircraft as measured by a rate gyro. Digital computer programs were used to calculate the relevant auto and cross-correlation functions, and the power spectra. The results, Bode plots and time responses agreed with theory. Author (ESRO)

N71-15721# Royal Aircraft Establishment, Farnborough (England). Structures Dept.

VERTICAL ACCELERATION IN THE COCKPIT OF A SUBSONIC TRANSPORT AIRCRAFT DURING TAKE-OFF MEASURED DURING AIRLINE OPERATION

C. G. B. Mitchell London Aeron. Res. Council 1970 38 p refs Supersedes RAE-TR-69215; ARC-32122; CAADRP-TR-18

(ARC-CP-1120; RAE-TR-69215; ARC-32122; CAADRP-TR-18) Copyright. Avail: NTIS; HMSO 45p; BIS: $1.80

The vertical acceleration in a Boeing 707-436 cockpit was measured during 94 take-offs and that near the center of gravity (c.g.) during 33 take-offs from 31 airports. At a given airport the cockpit acceleration at a weight of 140,000 kg was about twice that at 90,000 kg but the c.g. acceleration did not vary with weight. The cockpit acceleration amplitude varied between airports by a factor of about two at 115,000 kg. The cockpit/c.g. acceleration ratio was between 0.9 and 2.3, but for more than 80% of take-offs was between 1.0 and 1.5. The vibration levels experienced had no detectable effect on errors of rotation speed at take off. Author (ESRO)

N71-15722# Royal Aircraft Establishment, Farnborough (England). Structures Dept

OPERATIONAL AND THEORETICAL STUDIES ON THE EFFECT OF PILOT ACTION ON HEAVY LANDINGS

H. Hall and G. B. Hutton London Aeron. Res. Council 1970 38 p refs Supersedes RAE-TR-69278; ARC-321146

(ARC-CP-1119; RAE-TR-69278; ARC-32146) Copyright. Avail: NTIS; HMSO: 50p; BIS: $2.00

Pilot action can modify the consequences of heavy landings involving bounce, both beneficially and detrimentally. Large elevator movements, leading to fluctuations in lift, can increase bounce height and structural loadings. Author (ESRO)

N71-15804# Aeronautical Research Council (Gt. Brit.).

STUDIES OF THE TURBULENT BOUNDARY LAYER ON A WAISTED BODY OF REVOLUTION IN SUBSONIC AND SUPERSONIC FLOW

K. G. Winter (RAE, Bedford), J. C. Rotta (Aerodyn. Versuchsanstalt), and K. G. Smith (RAE, Bedford) 1970 79 p refs Supersedes RAE-TR-68215; ARC-30935

(ARC-R/M-3633; RAE-TR-68215; ARC-30935) Copyright. Avail: NTIS; HMSO: £2; BIS: $7.20

The influence of Mach number, pressure gradients, and streamline convergence and divergence on the development of turbulent boundary layers was studied. Measurements were made of pressure distribution, local skin friction and boundary-layer profiles along the body, at Mach numbers between 0.6 and 2.8 and Reynolds numbers, based on the length of the body, between 5 and 20 million. The results of comparative calculations based on simultaneous integration of the momentum and kinetic energy equations were in fair agreement with the experiments except at Mach numbers 2.4 and 2.8. Author (ESRO)

N71-15819*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

DESIGN OF THE 20-MEGAWATT LINEAR PLASMA ACCELERATOR FACILITY

Arlen F. Carter, Willard R. Weaver, Donard R. McFarland, Stephen K. Park, and George P. Wood Washington Jan. 1970 54 p refs

(NASA-TN-D-6115; L-7405) Avail: NTIS CSCL 20I

The design of the 20-megawatt linear plasma accelerator facility at the Langley Research Center is described. This linear, steady-flow, Faraday-type plasma accelerator is intended for high-velocity aerodynamic testing and basic research in magnetohydrodynamics. Discussion is included on the general design philosophy that leads to three design criteria: (1) make the vector product of current density and magnetic flux density as large as practicable, (2) operate with approximately constant current density, and (3) maintain the Hall potential gradient constant across and along the channel. Use was made of experience and results obtained with previous smaller, lower velocity accelerators. The design exit velocity is 13 km/sec at a density that corresponds to an altitude of 53 km. Many aspects of the engineering design of the accelerator and auxiliary equipment are discussed. Author

N71-15820*# National Aeronautics and Space Administration. Flight Research Center, Edwards, Calif.

ENGINE EXHAUST NOISE DURING GROUND OPERATION OF THE XB-70 AIRPLANE

Paul L. Lasagna and Terrill W. Putnam Washington Jan. 1971 36 p refs

(NASA-TN-D-7043; H-599) Avail: NTIS CSCL 01A

Engine noise of XB-70 aircraft was measured from 90 deg to 160 deg from the airplane heading at a radius of 500 feet (152 meters). Overall sound pressure levels, perceived noise levels, and normalized spectra are presented for jet exhaust velocities up to 3300 feet/second (1006 meters/second), various engine spacings, and various numbers of adjacent engines operating. The direction of propagation of maximum noise levels moved from 135 deg to 120 deg as either the jet velocity was increased or the number of adjacent engines operating was increased. As the distance between two operating engines became greater, the overall sound pressure level increased as the angle between the microphone position and the exhaust axis decreased. The overall sound pressure level agreed best with the SAE prediction levels at an angle of 120 deg for exhaust velocities between 1500 feet/second (457 meters/second) and 3000 feet/second (914 meters/second). The SAE method adequately estimated the noise spectrum of the XB-70 airplane for subsonic exhaust flow and underestimated the high-frequency spectral levels for supersonic flow. Some shielding of the high frequencies was observed when two or more adjacent engines were operating in supersonic exhaust flow conditions. The noise spectrum shape was independent of jet exhaust velocity for the XB-70 engines with supersonic flow. Author

N71-15827*# Pennsylvania State Univ., University Park. Dept. of Aerospace Engineering.

A NUMERICAL SOLUTION OF THE UNSTEADY AIRFOIL WITH APPLICATION TO THE VORTEX INTERACTION PROBLEM

Wylie E. Rudhman Dec. 1970 89 p refs

(Grant NGR-39-009-111)

(NASA-CR-111843) Avail: NTIS CSCL 20D

A numerical method to predict the aerodynamic forces acting on a thin airfoil operating in an unsteady potential flow is developed. A distribution of discrete point vortices placed on an arbitrary camber line represents the airfoil. The time dependent solution including wake generation is obtained starting with the system at rest. A rigid wake assumption is used where the wake vortices lie in the direction of the chord line and move with the free stream velocity. The results of the numerical solution are shown to agree with results using the classic theories of Theodorsen for the oscillating airfoil and of Wagner for the impulsively started airfoil. Using the numerical method, a parametric study is conducted to determine the time history of the loads on an airfoil produced by a vortex passing in proximity to the airfoil. Results of the study are compared to an experimental investigation of the rotor blade-vortex interaction problem. Author

N71-15923# Army Aviation Systems Test Activity, Edwards AFB, Calif.

FLIGHT EVALUATION AN/APN 191 RADAR ALTIMETER *Final Report, Feb. 1968–Jul. 1970*

Gary L. Bender and John R. Burden Sep. 1970 31 p refs

(AD-714638; USAASTA-68-13) Avail: NTIS CSCL 1/4

A flight evaluation of the AN/APN 191 radar altimeter was conducted to determine its accuracy and suitability as a test instrument. The testing consisted of 9.7 flight hours with the altimeter system installed in a UH-1C helicopter. Results show that the AN/APN 191 altimeter system has a large random error and is not as accurate as present altitude determination methods. Therefore, this altimeter is unsatisfactory as a test instrument. The indicator scale and sensitivity were excellent; and the accuracy was not affected by attitude, vertical speed, or airspeed variations. Author (GRA)

N71-15925* National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

HYPERSONIC TEST FACILITY Patent

Frank L. Clark, Charles B. Johnson, Wayne D. Erickson, and Roger I. Buchanan, inventors (to NASA) Issued 1 Mar. 1966 (Filed 18 Mar. 1963) 10 p Cl. 219-10.49

(NASA-Case-XLA-00378; US-Patent-3,238,345; US-Patent-Appl-SN-266107) Avail: NTIS CSCL 14B

A hypersonic test facility is described for studying ablation in models under high pressure and high temperature conditions. It includes a heat exchanger with the capability of heating a test gas from room temperature to an exit temperature of 3,000 to 4,000 R, for sustained periods of time, by a graphite heater in a pressure chamber of 5,000 psi. The graphite heater element through which the test fluid passes is heated to a high temperature by induction, and is expanded through a water-cooled nozzle to the test section. F.O.S.

N71-15926* National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

TEST UNIT FREE-FLIGHT SUSPENSION SYSTEM Patent

Wilmer H. Reed, III, inventor (to NASA) Issued 4 Oct. 1966 (Filed 16 Sep. 1963) 7 p Cl. 73-147

(NASA-Case-XLA-00939; US-Patent-3,276,251; US Patent-Appl-SN-309354) Avail: US Patent Office CSCL 14B

A free flight suspension system is described for use with aircraft models in wind tunnels. Pulleys mounted on the test model, arranged so that cables connected to the top, bottom and sidewalls, entrained over the pulleys provide six degrees of freedom for the model in wind tunnel tests. F.O.S.

N71-15963# Rocketdyne, Canoga Park, Calif. Mathematics and Statistics Research Div.

FREE BOUNDARY VALUE PROBLEMS OF HEAT FLOW AROUND AERODYNAMIC BODIES AND CONTROL THEORY Final Report

B. Sherman and R. Van Wyk 17 Sep. 1970 23 p refs

(Contract AF 49(638)-1679)

(AD-714621; R-8363; AFOSR-70-2533TR) Avail: NTIS CSCL 20/13

Research results concerned primarily with qualitative aspects of free boundary problems are reviewed. These results are in the following areas: (1) existence and uniqueness for the one-phase

nonhomogeneous Stefan problem, (2) continuous dependence on the data for the same problem, (3) existence of solution and behavior of the free boundary for the general one-phase Stefan problem, (4) behavior of the free boundary when it coincides initially with the fixed face, (5) convergence when the latent heat goes to zero, and (6) existence and uniqueness for free boundary problems for the heat equation in which Cauchy data is prescribed on the free boundary. Author (GRA)

N71-15964*# Boeing Co., Seattle, Wash.
STUDY AND DEVELOPMENT OF TURBOFAN NACELLE MODIFICATIONS TO MINIMIZE FAN-COMPRESSOR NOISE RADIATION. VOLUME 3: CONCEPT STUDIES AND GROUND TESTS Contractor Report, 1 May 1967 1 Nov. 1969
Washington NASA Jan 1971 84 p ref
(Contract NAS1-7129)
(NASA-CR-1713) Avail: NTIS CSCL 21E

The program objective was the reduction by 15 PNdB of Boeing 707-320B/C airplane noise during landing approach. It was determined that this goal could be achieved by attenuating the fan noise of the P & W JT3D engines by acoustically treating the engine nacelle. The nacelle fan exhaust duct design was required to contribute the full 15-PNdB attenuation, while the inlet need only attenuate 10 PNdB, since forward noise radiation was five PNdB lower. Various configurations of the inlet and fan duct, with acoustic treatment, were studied. The inlet design selected has two concentric rings supported from the cowl by struts at eight radial locations. Polyimide fiberglass acoustic sandwich material is used integrally with the structure of the concentric rings, inner cowl wall, and centerbody. A full length fan exhaust duct with annular nozzle essentially coplanar with the primary nozzle was selected. Acoustic treatment was applied to approximately one-third of the duct length in which inner and outer duct walls as well as four radial flow channel splitters are of polyimide fiberglass acoustic/structural sandwich materials. Ground test results, compared with baseline ground test data on the 707 airplane production nacelle, showed approximately two percent increase in thrust due to the new duct design. This gain is offset by increased recovery loss of the new inlet. A takeoff thrust noise reduction of five to six PNdB was predicted from the test results. Author

N71-16019# Human Engineering Labs., Aberdeen Proving Ground, Md.
SUITABILITY FLIGHT TEST OF THE KAISER FP-50A DISPLAY UNIT IN THE H-1G (COBRA) HELICOPTER
Harry R. Stowell and Murray Foster, Jr. Sep. 1970 30 p refs
(AD-714670; HEL-TN-9-70) Avail: NTIS CSCL 19/5

The Kaiser FP-50A display unit is modified to provide tactical information to the pilot. Inputs are received from the gunners sight to present steering information for the pilot to maneuver the aircraft into position to fire rockets at a target being tracked by the gunner. The report presents work performed to support the SEA NITEOPS Program. Human factors engineering guidance is provided to the program by the Human Engineering Laboratories. This phase of the program involved making a human factors evaluation of the Kaiser FP-50A flight display integrated with the AH-1G (COBRA) weapon system (XM-28). Author (GRA)

N71-16029*# North Carolina State Univ., Raleigh. Center for Acoustical Studies.
ENGINEERING ANALYSIS AND DESIGN OF A MECHANISM TO SIMULATE A SONIC BOOM
Rolin F. Barrett and Lawrence W. Redman Aug. 1970 61 p refs
(Grant NGL-34-002-095)
(NASA-CR-111839) Avail: NTIS CSCL 14B

A mechanism to simulate the vibrational and acoustic properties of a sonic boom was designed. The simulator reproduces the effects of sonic booms having N-wave shape with rise times as low as ten milliseconds, durations as short as 161 milliseconds, and peak overpressures as high as three pounds per square foot. A systematic engineering analysis was performed to establish the best simulator design. Each design was examined to ascertain its ability to generate the properties of a sonic boom, its ease of adjustment, and its lack of background noise. The final design chosen employs a moving circular diaphragm which creates the required pressure variations by altering the volume of an airtight chamber connected to an acoustical testing room. The diaphragm is designed so that a minimum of force is required for its movement. The movement of the diaphragm is controlled by the rotation of a specially designed adjustable cam, and a constant force air cylinder. Author

N71-16039# Advisory Group for Aerospace Research and Development, Paris (France).
AEROELASTIC TEST METHODS: EXPERIMENTAL TECHNIQUES
G. Piazzoli Dec. 1970 36 p refs Transl. into ENGLISH of ONERA, Paris, report Revised
(AGARD-R-573-70) Avail: NTIS CSCL 01C

A survey is given of flight-test methods for investigating the dynamic stability of aircraft, including an appraisal of the capabilities of recently developed practical techniques. It is pointed out that there is a close interdependence between flight tests and other methods, such as ground vibration tests, the determination of aerodynamic coefficients, either theoretically or experimentally, and the calculation of critical speeds. The choice of flight test method depends on weight, dimensions, electrical power of the installation, nature and frequency of the modes, and means of analysis. Emphasis is laid on the importance of step-by-step exploration of critical areas of the flight range of a prototype. Author

N71-16059# National Transportation Safety Board, Washington, D.C.
[AIRCRAFT ACCIDENT PRELIMINARY REPORT:] CAPITOL INTERNATIONAL AIRWAYS, INCORPORATED, MCDONNEL DOUGLAS DC-8-63F N4909C, ANCHORAGE, ALASKA, 27 NOVEMBER 1970 News Release.
28 Jan. 1971 10 p
(SB-71-5) Avail: Issuing Activity

A preliminary report of the known facts in the accident of the Capitol International Airways Flight C2C3/26 is presented. The airplane crashed and burned at a point 3400 feet from the end of Runway 6R at Anchorage, Alaska. The investigations to determine the cause of the accident are continuing to obtain data relative to the ability of the aircraft wheels to rotate properly under conditions of low tire-to-runway surface friction coefficients, and tests of the airplane's brake assemblies are being conducted to determine the overall condition and performance capability of these units. F.O.S.

N71-16060# Advisory Group for Aerospace Research and Development, Paris (France).
SIMULATION AGARD CONFERENCE PROCEEDINGS
Jan. 1971 188 p refs AGARD Flight Mech. Panel Specialists Symp. held at Moffett Field, Calif, 10-13 Mar. 1970
(AGARD-CP-79-70) Avail: NTIS

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N71-16061# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Oberfaffenhofen (West Germany). Inst. fuer Dynamik der Flugsysteme.

SIMULATION: AN INTRODUCTION AND SURVEY

Gerhard F. Bruening *In* AGARD Simulation Jan. 1971 18 p refs

Avail: NTIS

A review is given on the state of the art of simulation. Linearized control theoretical aspects of simulation are discussed and examples of fixed base, moving base, and in-flight simulators are depicted with emphasis on the V/STOL problem. Ground simulators for environmental factors are analyzed with respect to motion, visual, and psychological parameters and methods for their simulation. The use of pilot opinion rating for evaluating simulation results is advocated. Differences between simulation on the ground and in the air are also outlined. G.G.

N71-16062# British Aircraft Corp., Preston (England).

OBJECTIVES OF SIMULATION

A. G. Barnes *In* AGARD Simulation Jan. 1971 8 p

Avail: NTIS

Simulations are used to: (1) derive statements about properties of a system which may be read across to real situations; (2) provide a framework for the interpretation of experiments; (3) improve a model; and (4) suggest further experiments. Flight simulation experiments provide accelerated development of aircrafts at reduced costs by defining what is required in order to transfer results readily with increased confidence to the real situation and thus cut down on trial and error aspects. G.G.

N71-16063# Boeing Co., Seattle, Wash.

LIGHT SIMULATOR MATHEMATICAL MODELS IN AIRCRAFT DESIGN

Alan H. Lee *In* AGARD Simulation Jan. 1971 23 p refs

Avail: NTIS

Mathematical models are discussed from the viewpoint of a flight simulation user. Aerodynamic, flight control system, and atmospheric environment models are stressed. Some of their considerations are discussed relative to aircraft design phases. A quasi-elastic format for representing the aerodynamic characteristics of a large, flexible aircraft is described. It is shown that storing aerodynamic data in digital computers as split functions has advantages. Such items as controller feel, hysteresis, and actuator characteristics should be included in the flight control system mathematical model. Turbulence and wind shears are essential to any realistic simulation program. The von Karman power spectral density function is preferred for turbulence generations. Emperical wind shears are also useful. Author

N71-16065# Societe Nationale Industrielle Aerospatial, Toulouse (France).

COCKPIT ENVIRONMENT

Jean Pinet *In* AGARD Simulation Jan. 1971 13 p refs

Avail: NTIS

Various inputs of the simulation environment during Concorde cockpit development are considered. Computerized simulator trials started out with the variable stability Mirage 3B aircraft by considering external and internal visual displays, inertial perceptions, and aural perception and verbal communications. Confrontation between simulation objectives and inputs and outputs of the crew members transfer functions with results from the various indices was used to define the environment simulation degree. G.G.

N71-16066# National Research Council of Canada, Ottawa (Ontario).

SOME FACTORS INFLUENCING THE CHOICE OF A SIMULATOR

D. M. McGregor *In* AGARD Simulation Jan. 1971 33 p refs

Avail: NTIS

Some of the means by which the pilot derives motion information during flight and attempts to highlight some of the areas in which specific simulator characteristics are required to obtain valid results are outlined. Discussions of several shortcomings of present hardware that must be overcome before specific tasks, such as low altitude, low speed maneuvering flight, can be simulated adequately and the difficulties of achieving a thorough understanding of the man-machine system are presented. Author

N71-16067# Cornell Aeronautical Lab., Inc., Buffalo, N.Y.

THE SELECTION OF TASKS AND SUBJECTS OF FLIGHT SIMULATION EXPERIMENTS

Waldemar O. Beuhaus and Robert P. Harper, Jr. *In* AGARD Simulation Jan. 1971 17 p

Avail: NTIS

The limitations of various simulators directly affect the simulation tasks which can be performed and, hence, affect the validity of the evaluation results obtained. The ability of simulator pilots to produce valid and repeatable evaluations which are applicable to the real-world situation can be no better than the accuracy with which the simulator tasks represent the essential characteristics of the real world. Certain considerations in the selection of simulator tasks are discussed, and problems are set forth which should be considered in the design of simulation experiments. The selection and preparation of evaluation pilots are discussed in terms of the factors which appear to have substantial effects upon the program results. Experience in the real-world mission is one of several key elements which greatly enchances the evaluation results. Preparation of subjects considers the importance and nature of communication between the subject pilot and the analyst, and participation of the subjects in the experimental design. Author

N71-16068# Centre d'Essais en Vol, Istres (France).

ENGINEERING ANALYSIS

M. Monfort *In* AGARD Simulation Jan. 1971 22 p refs

Avail: NTIS

The mixing of several simulation methods is advocated for engineering analyses on flight mechanics. Emphasis is placed on analysis of the pilot's behavior for integration in the man-machine

system by application of statistical and response surface techniques to both pilot ratings and pilot comments in measuring the pilot's workload. G.G.

N71-16069*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

PILOT ASSESSMENT ASPECTS OF SIMULATION

George E. Cooper and Fred J. Drinkwater, III *In* AGARD Simulation Jan. 1971 18 p refs

(NASA-TM-X-66583) Avail: NTIS CSCL 05H

Pilot assessment aspects of flight simulation consider the use of pilot ratings in the evaluation of aircraft handling qualities. Critical questions raised by pilots are examined and discussed in order to develop solutions and improve understanding. It is important to involve the pilot as early as possible in developing a piloted simulation program by considering complaints arising from simulation experiences as well as questions arising related to the pilot's actual participation in the planning and conducting of experiments, the simulation facility, and the analysis of results. Author

N71-16070# National Transportation Safety Board. Washington, D.C.

AIRCRAFT ACCIDENT PRELIMINARY REPORT: MISSISSIPPI VALLEY AIRWAYS, INCORPORATED, DE HAVILLAND DHC-6 N956SM, LACROSSE, WISCONSIN, 9 NOVEMBER 1970 News Release

29 Jan. 1971 9 p

(SB-71-6) Avail: Issuing Activity

A preliminary report of the known facts of the aircraft accident of the Mississippi Valley Airways, Inc., Flight 106 at LaCrosse, Wisconsin, on November 9, 1970 is presented. The crash of the DHC-6 occurred while executing a VOR approach in instrument flight conditions. F.O.S.

N71-16087* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

FLIGHT CRAFT Patent

Alfred J. Eggers, Jr., Clarence A. Syvertson, George G. Edwards, and George C. Kenyon, inventors (to NASA) Issued 4 Oct. 1966 (Filed 4 Feb. 1964) 11 p Cl. 244-1

(NASA-Case-XAC-02058; US-Patent-3,276,722; US-Patent-Appl-SN-342572) Avail: US Patent Office CSCL 01C

A flight craft is described which is suitable for space flight, reentry into an atmosphere, and atmospheric flight. The craft has a high ratio of volume-to-surface area and a low-drag aerodynamic shape, so that the deceleration force during reentry is within confortable limits. The vehicle is maneuverable by its own movable control surfaces and has a wide glide range for optimum selection of landing sites. R.B.

N71-16198# IIT Research Inst., Annapolis, Md.

FUTURE INSTRUMENT CANDING SYSTEM CHANNEL REQUIREMENTS

B. H. Metzger Oct. 1970 32 p refs

(Contract F19628-70-C-0291)

(AD-714111; ESD-TR-70-362) Avail: NTIS CSCL 17/7

As an aid to spectrum planning, estimates of the minimum channel requirements for the Instrument Landing System localizer are obtained for the 1970-1975 time period. Several alternatives in antenna systems, service volumes, assignment criteria and operational procedures are considered with respect to their possible impact on channel requirements. Author (GRA)

N71-16225# Army Foreign Science and Technology Center, Washington, D.C.

MATHEMATICAL MODELLING OF GAS TURBINE SUPERCHARGING IN MULTICYLINDER FOUR-CYCLE ENGINES [MATEMATICHESKOE MODELIROVANIE RABOTY SISTEM GAZOTURBINNOGO NADDUVA MNOGOTSILINDROVYKH CHETYREKHTAKTNYKH DVIGATELEI]

L. A. Samsonov 9 Feb. 1970 16 p refs Transl. into ENGLISH from Energomashinostroenie (Moscow), v. 13, no. 9, 1967 p 19-22

(AD-713873; FSTC-HT-23-358-70) Avail: NTIS CSCL 21/7

The principle features are presented of a method of mathematical modelling of the operation of a supercharging system for multicylinder four-cycle engines developed; a comparison is presented of the results of modelling of the operation of the supercharger for engine 4CHN15,5/20.5 using the Ural-2 computer with experimental data. Examples are presented of the investigation of the influence of design of the system on its parameters. GRA

N71-16252# Air Force Missile Development Center, Holloman AFB, N.Mex.

CALIBRATION AND CHARTING OF THE RAIN SIMULATION FACILITY AT THE HOLLOMAN AIR FORCE BASE TRACK

Hans J. Rasmussen Jul. 1970 32 p refs

(AD-714554; MDC-TR-70-28) Avail: NTIS CSCL 14/2

Some basic considerations governing rain erosion testing on the Holloman AFB Test Track are presented, and the equipment used for generating artificial rain is described to the extent relevant to charting the rain field. Some characteristics governing application of the IITRI rain counter are discussed and the analysis of data obtained by this instrument is outlined. Author (GRA)

N71-16261# California Inst. of Tech., Pasadena.

A THEORY OF TWO-DIMENSIONAL AIRFOILS WITH STRONG INLET FLOW ON THE UPPER SURFACE Final Report, 1 Nov. 1967 - 31 Dec. 1969

Sedat Serdengecti and Frank E. Marble Aug. 1970 59 p refs

(Contract F33615-68-C-1013)

(AD-714076; ARL-70-0139) Avail: NTIS CSCL 1/3

The two-dimensional theory of airfoils with arbitrarily strong inlet flow into the upper surface was examined with the aim of developing a thin-airfoil theory which is valid for this condition. Such a theory has, in fact, been developed and reduces uniformly to the conventional thin-wing theory when the inlet flow vanishes. The integrals associated with the arbitrary shape, corresponding to the familar Munk integrals, are somewhat more complex but not so as to make calculations difficult. To examine the limit for very high ratios of inlet to free-stream velocity, the theory of the Joukowski airfoil was extended to incorporate an arbitrary inlet on the surface. Because this calculation is exact, phenomena observed in the limit cannot be attributed to the linearized calculation. These results showed that airfoil theory, in the conventional sense, breaks down at very large ratios of inlet to free-stream velocity. This occurs where the strong induced field of the inlet dominates the free-stream flow so overwhelmingly that the flow no longer leaves the trailing edge but flows toward it. Then the trailing edge becomes, in fact a leading edge and the Kutta condition is physically inapplicable. For the example in this work, this breakdown occurred at a ratio of inlet to free-stream velocity of about 10. This phenomenon suggests that for ratios in excess of the critical value, the flow separates from the trailing edge and the circulation is dominated by conditions at the edges of the inlet. Author (GRA)

N71-16262# Army Aviation Systems Test Activity, Edwards AFB, Calif.

ROTARY WING VEHICLE EXTERNAL STORES JETTISON ENVELOPE PILOT ESTABLISHED REQUIREMENTS Final Report, Mar. 1968 - Feb. 1970

Wayne B. Davis and Alan L. Hoffman Aug. 1970 44 p refs

(AD-713872; USAASTA-68-22) Avail: NTIS CSCL 1/3

The numbers and types of Army helicopters having external stores configurations have increased significantly in recent years. Extensive testing has been required to establish or demonstrate the jettison envelope. In some cases, this envelope has not always been compatible with the mission requirements since there is no firm guidance concerning the aircraft/stores interface or requirements for the stores jettison capability or characteristics. The jettison envelope study program was designed to examine the envelope requirements from a pilots viewpoint and develop a technical basis for establishing design, demonstration and testing requirements. Either aerodynamic or forced separation may be used to satisfy the requirements. It was determined that the aircrafts stability and control characteristics can be used to define the minimum jettison envelope that can be perceived by the pilot. Of these characteristics, lateral side-force is the most reliable cue available to the pilot. This is a function of the static directional stability and effective dihedral. A lateral sideforce corresponding to an acceleration of 0.1g was recognized by all pilots participating in the program. A method is shown whereby this information can be used to develop a recognizable envelope from which the pilot should be able to safely jettison stores. This method can be used as a technical basis to provide design guidance, establish demonstration requirements and develop more effective testing procedures. Author (GRA)

N71-16281* National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
WIND VELOCITY PROBING DEVICE AND METHOD Patent
Robert F. Stengel, inventor (to NASA) Issued 21 Apr. 1970 (Filed 24 Jan. 1966) 8 p Cl. 73-189; Int. Cl. G01w1/08
(NASA-Case-XLA-02081; US-Patent-3,507,150;
US-Patent-Appl-SN-522795) Avail: US Patent Office CSCL 04B

Apparatus for probing an altitude interval and obtaining wind velocity profiles over the interval is described. A tubular body is released which has a light ballast weight, place forward for aerodynamic stability, and four large delta wings in cruciform arrangement. The wings are covered with aluminized Mylar film to provide a lifting and radar-reflective surface for tracking during free fall. Lateral deviations of the body from the vertical are measured, indicating the wind velocities at the various altitudes. N.E.N.

N71-16290# Ohio State Univ. Research Foundation, Columbus.
HYPERSONIC VISCOUS INTERACTION. AN EXPERIMENTAL INVESTIGATION OF THE FLOW OVER FLAT PLATES AT INCIDENCE AND AROUND AN EXPANSION CORNER
John L. Stollery Wright-Patterson AFB, Ohio ARL Jul. 1970 48 p refs
(Contract F33615-67-C-1758)
(AD-714074; ARL-70-0125) Avail: NTIS CSCL 20/4

Flat plate and expansion corner models were tested over a range of positive and negative incidences in a continuous hypersonic wind tunnel operating at M = 14.8. Surface pressure distributions were obtained for comparison with the viscous interaction theories of Cheng and Sullivan. Since these theories assume local flat plate similarity for the boundary layer flow, pitot pressure profiles were measured at various stations along the plates. It often proved difficult to define the boundary layer edge within the shock layer and total temperature profiles would greatly assist in interpreting the data. Schlieren pictures and oil flow visualization gave good indications of the extent of end effects, the onset of separation caused by the trailing edge shock wave, and tunnel blocking at high model incidence. The tests have provided some new hypersonic experimental data under conditions where both strong viscous interaction and incidence effects are important. Author (GRA)

N71-16295# Naval Research Lab., Washington, D.C.
SIMULATION MODEL FOR THE AADC
William R. Smith Sep. 1970 18 p
(AD-714140; NRL-MR-2172) Avail: NTIS CSCL 17/7

A Navy program to develop a flexible airborne computer which will be compatible with changing avionics mission requirements has led to an effort to implement a computer simulation of the proposed avionics system under representative program workloads. Realistic modeling of system software and hardware requires a simulation which reveals the effect of interaction between segments of program and computer resources. The SIMSCRIPT programming language is being used to implement an event oriented simulation of the avionics multiprocessor and its attendant workload. Examination of the utilization of system resources in the model will aid in determining the optimum computer configuration from among choices under consideration. Author (GRA)

N71-16309# Naval Ship Research and Development Center, Washington, D.C. Dept. of Aerodynamics.
NUMERICAL DETERMINATION OF THE FLOW FIELD ABOUT AXISYMMETRIC AND TWO-DIMENSIONAL BODIES IN SUPERSONIC FLOW
Robert H. Thompson and Roger J. Furey Mar. 1970 91 p refs
(AD-713917; Aero-1162; NSRDC-3032) Avail: NTIS CSCL 20/4

A computer program for calculating the aerodynamic characteristics and local flow properties for an arbitrary axisymmetric or two-dimensional body in supersonic flow is developed. The supersonic portion of the flow field is calculated by the method of characteristics. A conical flow solution provides the starting conditions for a sharp body with an attached shock; for a blunt body detached shock case, a method of integral relations solution provides the starting conditions. The flow field is treated as inviscid with the boundary layer effects being determined by the reference temperature method and a modified Reynolds analogy in the laminar case and the method of Spalding and Chi in the turbulent case. Manglers transformation accounts for transverse curvature in the laminar flow case. Details of the entire flow field are provided including any secondary shocks which may arise as a result of overexpansion or flared surfaces. Base flow properties are provided by the semiempirical method of Love. The calculated surface properties include pressure, equilibrium temperature, skin friction and heat transfer coefficients, and Mach number. Drag coefficients are determined with the components being broken down into pressure, friction and base contributions. Author (GRA)

N71-16452# Army Engineer Waterways Experiment Station, Vicksburg, Miss.
THICKNESS REQUIREMENTS FOR UNSURFACED ROADS AND AIRFIELDS: BARE BASE SUPPORT Final Report, May - Oct. 1966
George M. Hammitt, II Jul. 1970 149 p refs
(AD-713897; AEWES-TR-S-70-5) Avail: NTIS CSCL 1/5

A method was developed for determining design thickness requirements for unsurfaced airfields. Tests were conducted on a total of 43 unsurfaced test items. These items had varying thicknesses and were trafficked under different loading conditions. CBR, water content, density, deflection, and deformation data were recorded throughout testing. The design expression relates thickness requirements to soil response in terms of applications of load, load magnitude and pressure, and strength of soil. Author (GRA)

N71-16492# Systems Development Corp., Huntsville, Ala.
STUDY OF THE USAF TACTICAL AIR CONTROL SYSTEM (TACS)
23 Oct. 1970 81 p refs
(Contract DAAH01-70-C-0983)
(AD-714292; TM-L-HU-035/000/01) Avail: NTIS CSCL 17/7

The information search study provides a description of the Tactical Air Control System (TACS) and the improvement program 407L. TACS is comprised of four major subsystems: Aircraft Control and Warning, Tactical Air Support, Air Traffic Control and

Command Communications. Operating elements and major equipment components of the four subsystems are described with particular emphasis placed on the CRC/CRP AN/TSQ-91 of the Aircraft Control and Warning subsystem. Author (GRA)

N71-16533*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
EXPERIMENTAL AERODYNAMIC PERFORMANCE CHARACTERISTICS OF A ROTOR ENTRY VEHICLE CONFIGURATION. 1: SUBSONIC
Ronald C. Smith and Alan D. Levin Washington Feb. 1971 43 p refs
(NASA-TN-D-7046; A-3709) Avail: NTIS CSCL 01C

Wind tunnel tests were conducted to determine the aerodynamic performance characteristics of an unpowered rotor entry vehicle configuration at Mach numbers of 0.3 and 0.7. Rotor blade configurations having double wedge and modified ellipse profiles were tested at vehicle angles of attack from 15 to 90 deg. The ellipse profile was tested for rotor diameters of 45 and 60 inches. Variable blade collective pitch was used to control rotor rotational speed. It was found that the rotor had an unstable operating range at tunnel speeds up to M = 0.3 for the low-angle glide attitudes. At higher speeds, manual control of rotor RPM was simple and straightforward. Test results indicate that the rotor produced destabilizing pitching moments putting the test configuration out of longitudinal trim in glide attitude. At M = 0.3 the maximum lift-drag ratio was about 2.6 for the long-blade configuration, and 1.8 for both short-blade configurations. At M = 0.7 the maximum lift-drag ratio was 1.1 for all the test configurations. Author

N71-16534*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
EXPERIMENTAL AERODYNAMIC PERFORMANCE CHARACTERISTICS OF A ROTOR ENTRY VEHICLE CONFIGURATION. 2: TRANSONIC
Alan D. Levin and Ronald C. Smith Washington Feb. 1971 46 p refs
(NASA-TN-D-7047; A-3710) Avail: NTIS CSCL 01C

Wind tunnel tests were conducted to determine the aerodynamic performance characteristics of an unpowered rotor entry vehicle configuration at Mach numbers from 0.91 to 1.11. Blade collective pitch angle was varied for model angles of attack from 15 to 90 deg. The effectiveness of cyclic pitch controls at 15 and 25 deg angle of attack was also tested. Rotor blade configurations having double wedge and modified ellipse profiles were tested in combination with a 15-inch diameter capsule forebody. The ellipse profile was tested for rotor diameters of 45 and 60 inches. It was found that neither blade-section shape nor Mach number had significant effect on the aerodynamic characteristics. The rotor produced large positive pitching moments at low and intermediate angles of attack which could not be trimmed with the range of cyclic pitch controls available. Moderate rolling moments were produced by the rotor which could be trimmed with the longitudinal cyclic pitch control. The maximum lift-drag ratio was about 0.75 for the short blade configurations and nearly 1.0 for the long blade configuration. Author

N71-16535*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
EXPERIMENTAL AERODYNAMIC PERFORMANCE CHARACTERISTICS OF A ROTOR ENTRY VEHICLE CONFIGURATION. 3: SUPERSONIC
Ronald C. Smith and Alan D. Levin Washington Feb. 1971 56 p refs
(NASA-TN-D-7048; A-3711) Avail: NTIS CSCL 01C

Wind tunnel tests were conducted to determine the aerodynamic performance characteristics of an unpowered rotor entry vehicle configuration at Mach numbers from 1.62 to 3.54. Two rotor blade configurations with double-wedge and modified-ellipse profiles were tested at vehicle angles of attack from 15 to 90 deg. Variable blade collective pitch was used to control rotor rotational speed. Results of the tests indicate that the rotor speed is well behaved and manually controllable through blade pitch. The maximum L/D varied from 0.75 at Mach number 1.62 to 0.68 at Mach number 3.54. The rotor produced destabilizing pitching moments rendering the basic configuration unstable and out of trim in glide flight. Cyclic feathering was found to be inadequate for longitudinal trim but was satisfactory for roll trim. The addition of body-mounted pitch flaps provided the necessary trim and eliminated the instability over most of the speed range. Author

N71-16538*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
SUBSONIC AERODYNAMIC CHARACTERISTICS OF A MODEL OF HL-10 FLIGHT RESEARCH VEHICLE WITH BASIC AND MODIFIED TIP PINS
Linwood W. McKinney and Jarrett K. Huffman Washington Jan. 1971 561 p refs
(NASA-TM-X-2119; L-7430) Avail: NTIS HC $10.00/MF $0.65 CSCL 01C

A wind-tunnel investigation was made at Mach numbers from 0.35 to 0.80 to determine the cause for the loss in lateral control experienced on the basic HL-10 during the first flight. The results of the study indicate that the loss in lateral control was associated with flow separation originating near the leading edge of the outboard fins and spreading over the inner fin surface and elevon controls with increasing angle of attack. Two modifications to the fin leading edge were tested and both modifications were effective in significantly reducing the amount of flow separation and, as a result, the lateral control characteristics were improved. Author

N71-16539*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
EXPLORATORY INVESTIGATION OF THE STRUCTURE OF THE TIP VORTEX OF A SEMISPAN WING FOR SEVERAL WING-TIP MODIFICATIONS
James Scheiman and James P. Shivers Washington Feb. 1971 46 p refs
(NASA-TN-D-6101; L-7309) Avail: NTIS CSCL 01A

Wind-tunnel tests were performed on a semispan wing with rather radical wing-tip modifications. These modifications were chosen in an attempt to deform, displace, or modify the cross-sectional characteristics of the trailing tip vortex. The wing-tip modifications tested did not grossly affect the spanwise lift distribution and did not produce a noticeable change in the position of the downstream tip vortex. Tip-vortex cross-sectional variations were obtained such that the outer flow field was no longer potential flow. Author

N71-16549# ARO, Inc., Arnold Air Force Station, Tenn.
WIND TUNNEL PRESSURE MEASURING TECHNIQUES Final Technical Report 1969 - 1970
D. S. Bynum, R. L. Ledford, and W. E. Smotherman AEDC Nov. 1970 102 p refs
(Contract F40600-70-C-0002)
(AD-714565; AEDC-TR-70-250) Avail: NTIS CSCL 14/2

The report was written to give those unacquainted with modern wind tunnel pressure measuring techniques and equipment a broad view of the topic and to provide sufficient references so that additional information may be easily obtained. The material covered is limited to direct pressure measurements, i.e., force per unit area, and does not present techniques that determine pressure through its relationship to other measured parameters. Transducers, signal conditioning, data recording equipment, and static and dynamic calibrations are described. Author (GRA)

N71-16554*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

ADVANCED DESIGN CONCEPTS FOR HIGH SPEED BEARINGS

Herbert W. Scibbe and Erwin V. Zaretsky [1971] 33 p refs Proposed for presentation at 1971 Design Eng. Conf. of the ASME, New York, 19 – 22 Apr. 1971

(NASA-TM-X-52958) Avail: NTIS CSCL 13I

Advanced rolling-element bearing technology has been developed that has enabled bearing operation to temperatures of 600 F in an inerted environment. Longer fatigue lives than with present day bearing lubricants have been obtained. More than 13 times the AFBMA-predicted (catalog) life was obtained with bearings using AISI M-50 ball and race materials, an AMS 4892 nickel-base steel cage material, and a synthetic paraffinic lubricant at temperatures from 400 to 600 F. A ball bearing design with 50-percent ball weight reduction has been run successfully for short time periods at DN values to 3 million. This concept offers promise of extending bearing fatigue life at high DN values. Author

N71-16557*# City Univ. of New York. Dept. of Civil Engineering.

TRANSMISSION OF SONIC BOOM PRESSURE THROUGH A WINDOW PANE

Jacques E. Benveniste and David H. Cheng Nov. 1970 19 p refs

(Grant NGR-22-013-039)

(NASA-CR-111846; Rept-9) Avail: NTIS CSCL 01C

In previous studies of the effects of sonic booms on structures, the structural elements were assumed to be subjected to the outside overpressure. Actually, a certain amount of energy is transmitted to the interior of the structure and exterior structural elements are subjected to a net pressure equal to the difference between exterior and interior overpressure. The computation of the actual net pressure would be a hopeless task since the interior overpressures depend on the multiple reflections and the absorption of sound waves by walls, floors and ceilings. As an approximation of the situation near a window, the case of an elastic plate set in a rigid, infinite baffle and subjected to a N-shaped sonic boom normal to its plane was studied. The plate was assumed square and simply supported along its edges. Author

N71-16558*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

PROBLEM AREAS FOR LIFT FAN PROPULSION FOR CIVIL VTOL TRANSPORTS

S. Lieblein 1970 35 p refs Presented at DGLR Symp. on VTOL Propulsion, Munich, 22 – 23 Oct. 1970

(NASA-TM-X-52907; E-5614-2) Avail: NTIS CSCL 01C

The feasibility of VTOL intercity air transportation systems has been explored by a number of American and European organizations and government agencies. It is recognized that there are many aspects to the problem of a VTOL transportation system – economic, sociological, and political, as well as technological. Examples of recent thinking on these aspects are presented. A total systems approach is undoubtedly required for the successful development of commercial VTOL. Author

N71-16564*# Boeing Co., Seattle, Wash.

STUDY AND DEVELOPMENT OF TURBOFAN NACELLE MODIFICATIONS TO MINIMIZE FAN-COMPRESSOR NOISE RADIATION. VOLUME 6: ECONOMIC STUDIES Contractor Report, 1 May 1967 – 1 Nov. 1969

Washington NASA Jan. 1971 54 p refs

(Contract NAS1-7129)

(NASA-CR-1716) Avail: NTIS CSCL 01C

The economic implications of installing treated nacelles on Boeing 707-320B airplanes powered by P & WA JT3D-3B engines are studied. Operating costs are estimated for the year 1972. It was found that international direct operating costs (DOC) increase by 9.2 percent and domestic DOC increase by 9.6 percent. The major factor in these increases is the increase of depreciation cost. The additional depreciation cost is based on a predicted total installed retrofit price for 1972 of $1 million per airplane. The increase of indirect operating costs due to the retrofit is considered to be negligible. A hypothetical fleet study shows that a small loss of revenue earning capacity is involved, particularly over long range stages. For the route network considered in the study, a 0.1 percent loss of passenger revenue, a 4.3 percent increase of total operating costs and a 4.3 percent reduction in return based on passenger revenue is estimated. Author

N71-16565# Naval Postgraduate School, Monterey, Calif. Dept. of Aeronautics.

AERODYNAMIC DESIGN OF SYMMETRICAL BLADING FOR THREE-STAGE AXIAL FLOW COMPRESSOR TEST RIG

Michael H. Vavra 1 Sep. 1970 62 p refs

(AD-714585; NSP-57VA70091A) Avail: NTIS CSCL 14/2

The report deals with the aerodynamic design of an axial compressor stage with symmetrical bladings for a research program to investigate tip clearance effects in a three-stage compressor. It establishes the blading data and the stage performance with an iterative three-dimensional approach, and gives criteria for the drive and the flow measuring device of the test unit. The calculated distributions of the flow properties in the stage will be used for future comparisons with test data. Author (GRA)

N71-16584*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

FLIGHT INVESTIGATION OF VTOL CONTROL AND DISPLAY CONCEPT FOR PERFORMING DECELERATING APPROACHES TO AN INSTRUMENT HOVER

John F. Garren, Jr., James R. Kelly, Robert W. Sommer, and Daniel J. Di Carlo Washington Feb. 1971 39 p refs

(NASA-TN-D-6108; L-7355) Avail: NTIS CSCL 01C

Described is a VTOL-oriented display and control concept which provides a capability of studying operational aspects of the decelerating approach problem. Flight tests were conducted with a research helicopter equipped with a control augmentation system and a flight-director display, along with more conventional situation displays. The tests documented the maximum deceleration rates that could be achieved, effects of winds, and approach and hover performance. Author

N71-16592*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

CONCEPTS FOR COST REDUCTION ON TURBINE ENGINES FOR GENERAL AVIATION

Robert L. Cummings and Harold Gold Feb. 1971 22 p Proposed for presentation at Western Metal and Tool Exposition Conf., Los Angeles, 8 – 11 Mar. 1971

(NASA-TM-X-52951) Avail: NTIS CSCL 21E

Current results of a study of methods for achieving drastic cost reduction on gas turbine engines for general aviation aircraft are presented. Performance trade-offs for engine simplicity are discussed. Results of fabrication studies on simplified axial stage constructions are presented. Author

N71-16616# Army Foreign Science and Technology Center, Washington, D.C.

RADIO DIRECTION FINDING

V. A. Vartanesyan et al 27 Feb. 1970 234 p refs Transl. into ENGLISH of the book 'Radiopelengatsiya' Moscow, Mil. Publishing House of the Min. of Defense of the USSR, 1966

(AD-714509; FSTC-HT-23-828-70; RA-012-68) Avail: NTIS CSCL 17/3

Discussed in the book are the theoretical principles of radio direction finding and the operating principles of the various types of radio direction finders. Questions concerned with the practical use of ground station radio direction finders are reviewed. A great deal of attention is devoted to accuracy in direction finding, and to the sensitivity of direction finding devices in accordance with the conditions under which radio waves are being propagated, the antenna and receiver-indicator system design used, and how the radio direction finders are operated. Author (GRA)

N71-16627*# McDonnell-Douglas Co., Long Beach, Calif.
INVESTIGATION OF DC-8 NACELLE MODIFICATIONS TO REDUCE FAN-COMPRESSOR NOISE IN AIRPORT COMMUNITIES. PART 4: FLIGHT ACOUSTICAL AND PERFORMANCE EVALUATIONS, FOR PERIOD MAY 1967 - OCTOBER 1969
E. L. Zwieback, E. M. Lowder, E. A. Ilkcagla, H. Andresen, C. A. Henry et al Washington NASA Dec. 1970 151 p refs
(Contract NAS1-7130)
(NASA-CR-1708) Avail: NTIS CSCL 01A

Acoustically-treated engine nacelles for Douglas DC-8-50/61 airplanes were flight tested using a DC-8-55 airplane. The flight noise and performance measurements were supplemented by measurements made on an engine test stand. Significant noise reductions were obtained with the nacelle modifications. Beneath the landing approach path, at a height of 370 ft and with a landing weight of 240,000 lb, the effective perceived noise level would be reduced by 10.5 EPNdB. Beneath the initial-climb flight path, a 325,000-lb airplane climbing with rated-takeoff thrust would produce 3.5 EPNdB less noise at a point 3.5 n. mi. from start of takeoff roll and 3 EPNdB less maximum noise along a 1500-ft sideline. Installed net thrust at rated-takeoff power was reduced 2.1 percent with the nacelle modifications. Cruise performance was improved with an average 3-percent increase in specific range. No adverse engine operational characteristics were encountered. Author

N71-16634*# Stanford Research Inst., Calif.
VHF BREAKDOWN ON A NIKE-CAJUN ROCKET
J. B. Chown, J. E. Nanevicz, and E. F. Vance *In* JPL Proc. of the 2d Workshop on Voltage Breakdown in Electron. Equipment at Low Air Pressure 30 Jun. 1970 p 19 28

Avail: NTIS CSCL 09E

The laboratory testing of a VHF quadraloop, Nike-Cajun type antenna is discussed, and results are compared to flight test data. The test procedures, theory, and difficulties in simulating flight conditions are described. The effects of altitude and plasma spreading on breakdown are considered, and two unexpected results are discussed. These are an aerodynamic effect due to the lowering of pressure behind the quadraloop, and the high altitude breakdown due to outgassing effects on multipacting. N.E.N.

N71-16660*# LTV Research Center, Anaheim, Calif.
TECHNIQUES FOR EVALUATING THE SOUND ABSORPTION OF MATERIALS AT HIGH INTENSITIES
John G. Powell and John J. Van Houten Washington NASA Jan. 1971 77 p refs
(Contract NAS1-8763)
(NASA-CR-1698) Avail: NTIS CSCL 20A

Two unique methods applicable to evaluation of the sound absorption characteristics of materials have been investigated. The effort concentrated on methods suitable for evaluating materials under consideration for sound reduction treatment in jet engine nacelles. Since many sound absorbing materials become nonlinear at the sound intensities encountered in the intake and fan exhaust ducts, a need exists for a convenient method of testing at these intensities in the laboratory. Both techniques evaluated during this study are capable of fulfilling this requirement. The methods investigated involve a tone-burst technique and a shock-tube procedure. Author

N71-16685*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
AEROPHYSICS
In its Space Programs Sum. No. 37-65, Vol. 3, Aug. - Sep. 1970 31 Oct. 1970 p 156 - 157 refs
Copyright. Avail: NTIS CSCL 20D

Tests of supersonic boom pressures were made for a series of model configurations in the JPL 20-in. supersonic wind tunnel, which provides the flow characteristics required for good sonic boom studies. Mach number variation in the test rombus is 0.01 M and flow angularity has been found to be + or - 0.1 deg. Total pressure variation was less than 0.2% during the tests. Pressure data in the near-disturbance field of the test model were measured by a long slender static pressure probe mounted rigidly near the tunnel floor. The low differential pressure between the probe and a tunnel wall static pressure port were measured by a Barocell transducer and were recorded on a digital voltmeter. Models were mounted on a sting, and could be translated fore and aft over the probe to record the complete pressure signature. Author

N71-16686*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
SPACE SIMULATION
In its Space Programs Sum. No. 37-65, Vol. 3, Aug. - Sep. 1970 31 Oct. 1970 p 158 - 162 refs
Copyright. Avail: NTIS CSCL 03B

During X-15 flight 3-64-95 successful solar irradiance data were obtained at an elevation of 75 to 80 km above sea level. Within the pass-band of the instrument this elevation represents essentially the extraterrestrial solar flux. The design details of the multichannel radiometer are presented and calibration techniques are given. Integration of the radiometer into the pod of the X-15, solar orientation, computation, and signal conditioning are discussed. The solar irradiance of the total and broad-bands are presented and the X-15 results are compared with the B-57 and CV990 data extrapolated from 12 km. The results of the narrow-band channels are reported and these values are compared with the energy in the equivalent bands of four currently popular solar spectral irradiance curves. Author

N71-16713*# Cornell Aeronautical Lab., Inc., Buffalo, N.Y.
A FEASIBILITY STUDY FOR AN ADVANCED AVIONICS FLIGHT TEST AIRCRAFT Final Report
Robert C. Kidder Nov. 1970 74 p refs
(Contract NAS9-10987)
(NASA-CR-114832; CAL-VI-2973-F-1; MCS-02526) Avail: NTIS CSCL 01C

An engineering study was performed from which recommendations were generated for modification of an existing aircraft to a configuration that will be suitable for flight demonstration of the integrated electronics system intended to be used for the guidance and control of the reusable space shuttle vehicle. From a wide variety of aircraft initially examined, the candidate aircraft were reduced to three: the Convair 580, Lockheed P3D, and the Lockheed C-130. Cost estimates were prepared for the conversion of these three candidate aircraft to the configuration of the space shuttle vehicle electronics test aircraft. After review of the conversion costs, the C-130E aircraft was selected as the one most suitable to the mission requirements. A detailed specification was written which sets forth the requirements for conversion of the selected aircraft to the desired electronic test bed configuration. A copy of this specification is included. Author

N71-16818# National Aviation Facilities Experimental Center, Atlantic City, N.J.
AIR TRANSPORT CABIN MOCKUP FIRE EXPERIMENTS Final Report, 1966 - 1970
John F. Marcy Dec. 1970 43 p refs
(FAA-RD-70-81; FAA-NA-70-39) Avail: NTIS

A study was made of the burning characteristics of airplane interior materials ignited inside a 640-cubic-foot cabin mockup

enclosure. Test conditions were varied to investigate the effects of a number of factors on the ignition and propagation of flames within enclosures; namely: (1) flammability ratings of the materials as obtained from standard laboratory tests; (2) intensity, duration and type of the ignition source whether flaming or incandescent; (3) ventilation rate as provided by different size openings into the cabin enclosure; (4) partitioning of the cabin space by use of a fire barrier curtain; and (5) discharge of bromotrifluoromethane into the cabin atmosphere, both at different rates and total quantities of application before and during a fire occurrence. Comparative tests conducted on flame-retardant urethane and neoprene foams showed that the flash-fire hazard prevalent with the use of regular foam could be greatly reduced by replacement with these two self-extinguishing foams. A high-rate discharge system employing CF3Br(1301) was shown to be effective in rapidly extinguishing the flames of a foam fire. Author

N71-16858# National Aeronautics and Space Council, Washington, D.C.
AERONAUTICS AND SPACE REPORT OF THE PRESIDENT, JANUARY 1971
GPO Jan. 1971 118 p refs Presented to Congr., Jan. 1971
Avail: SOD: $1.25

New goals and objectives for continuing the progress of space achievements were announced based on three general purposes: space exploration, scientific knowledge and practical applications. Six specific objectives were outlined: (1) continued exploration of the moon; (2) bold exploration of the planets and the universe; (3) substantial reduction in the cost of space operations; (4) extension of man's capability to live and work in space; (5) expansion of the practical applications of space technology and (6) the encouragement of greater international cooperation in space. Author

N71-16864# Naval Air Propulsion Test Center, Philadelphia, Pa. Aeronautical Engine Dept.
CRASH FIRE HAZARD EVALUATION OF JET FUELS Final Report
Andrew J. Atkinson and Thor I. Eklund Jan. 1971 54 p refs
(Contract FA-66-NF-AP-14)
(FAA-NA-70-64; FAA-RD-70-72) Avail: NTIS

An investigation was conducted to determine the relative crash fire hazards of jet fuels under survivable crash conditions. Kerosene, JP-4, and mixtures of both were evaluated under various release modes (pools, drips, streams and sprays) and in the presence of possible ignition sources (electrical sparks, friction sparks, open flames, and hot surfaces). Wind speed, wind air temperature and fuel temperatures were also varied. The results of the evaluation and the conclusions reached are discussed. Author

N71-16874# Defence Documentation Center, Alexandria, Va.
URBAN ECONOMICS AND PLANNING, VOLUME 1 Report Bibliography, Jun. 1962 Mar. 1970
Oct. 1970 292 p refs
(AD-714500; DDC-TAS-70-73-1) Avail: NITS CSCL 13/2

The bibliography includes annotated references to reports on urban area problems, regional planning and development, sociometrics, urban renewal, transportation, traffic, noise and communications. Corporate author-monitoring agency, and subject, indexes are included. GRA

N71-16886# Dynamic Science, Irvine, Calif.
COMBUSTION CHEMISTRY AND MIXING IN SUPERSONIC FLOW Final Report
Stuart Hersh and Melvin Gerstein Sep. 1970 69 p refs
(Contract F44620-68-C-0069)
(AD-714109; DS-TR-A-70-103; AFOSR-70-1873TR) Avail: NTIS CSCL 21/2

Analytical and experimental investigations of the ignition and combustion of hydrogen-oxygen-argon mixtures are presented. A one-dimensional kinetics program with generalized chemistry and provisions for mass addition, momentum addition, heat loss, mixing, shock waves, and a rate screening option has been developed and used to analyze the effect of free radical additives on the ignition delay time in hydrogen-oxygen mixtures. The computer program has also been used to reduce shock tube measurements of hydrogen-oxygen ignition delay and OH doublet Sigma-doublet Pi emission. The experimental results indicate that the reaction O+H(+M) yielding OH*(+M) is responsible for producing OH(doublet Sigma) during the induction period; however, this mechanism, when input into the computer program, was not sufficient to qualitatively reproduce OH emission intensity profiles obtained experimentally. Work aimed at determining the mechanism for OH emission throughout the reaction zone is continuing. Author (GRA)

N71-16894* National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
VISCOUS-PENDULUM-DAMPER Patent
Wilmer H. Reed, III, inventor (to NASA) Issued 21 Mar. 1967 (Filed 26 Feb. 1965) 9 p Cl. 188-87
(NASA-Case-XLA-02079; US-Patent-3,310,138;
US-Patent-Appl-SN-435756) Avail: US Patent Office CSCL 20D

A viscous pendulum damper having linear damping characteristics is described. The device was designed for bidirectional operation with precise regulation of damping for either tuned or untuned operation. By not requiring guy wires or external connections, the aerodynamic problems associated with spring mass dampers are avoided, and an inexpensive means of remotely controlled damping is provided. Operation of the device involves one or more modules made up of numerous interfitting trays filled with a viscous fluid to react against disc shaped slugs positioned on the trays. By altering the number of slugs, or by varying the pressure activating the mercury filled bellows, the damping characteristics are altered. D.L.G.

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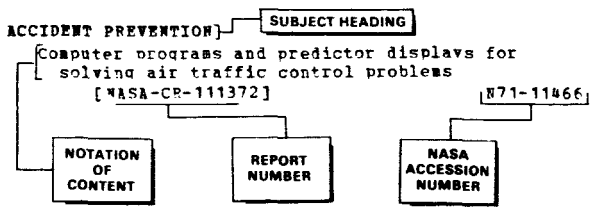

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Aerodynamic sound generation by turbulent circular free jets, presenting solution to inhomogeneous acoustical wave equation by Lighthill
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[NASA-CASE-XAC-02058] N71-16087
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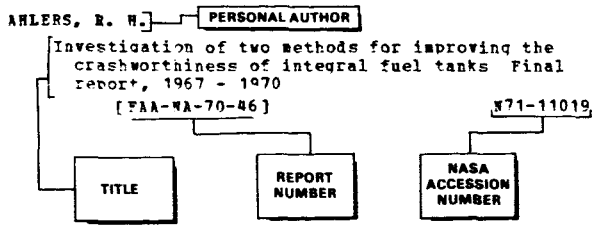

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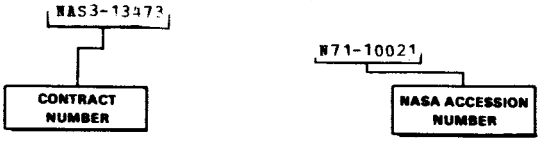

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1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
NASA SP-7037 (04)		

4. Title and Subtitle	5. Report Date
AERONAUTICAL ENGINEERING A Special Bibliography (Supplement 4)	April 1971
	6. Performing Organization Code
7. Author(s)	8. Performing Organization Report No.
	10. Work Unit No.
9. Performing Organization Name and Address National Aeronautics and Space Administration Washington, D. C. 20546	11. Contract or Grant No.
	13. Type of Report and Period Covered
12. Sponsoring Agency Name and Address	14. Sponsoring Agency Code

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17. Key Words (Suggested by Author(s))	18. Distribution Statement
Aerodynamics Aeronautical Engineering Aeronautics Bibliographies	Unclassified - Unlimited

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price*
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